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ELECTRONIC DESIGN

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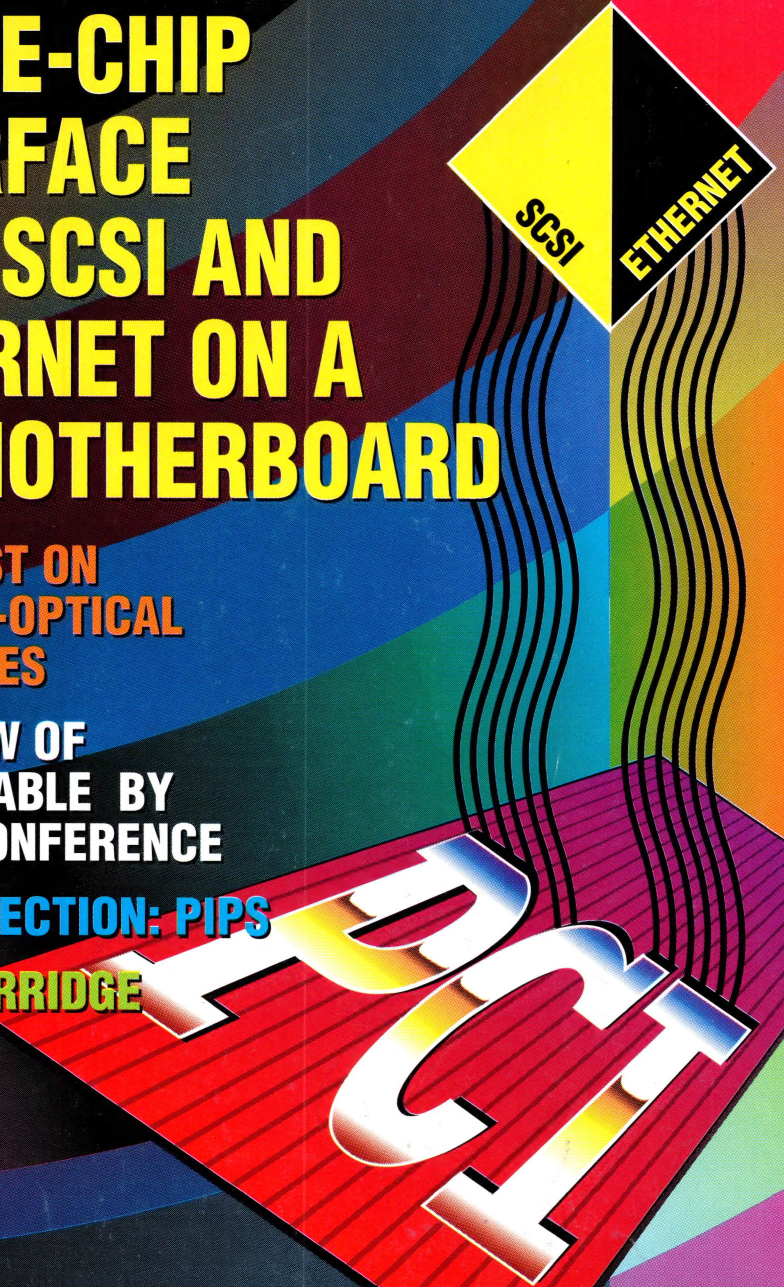

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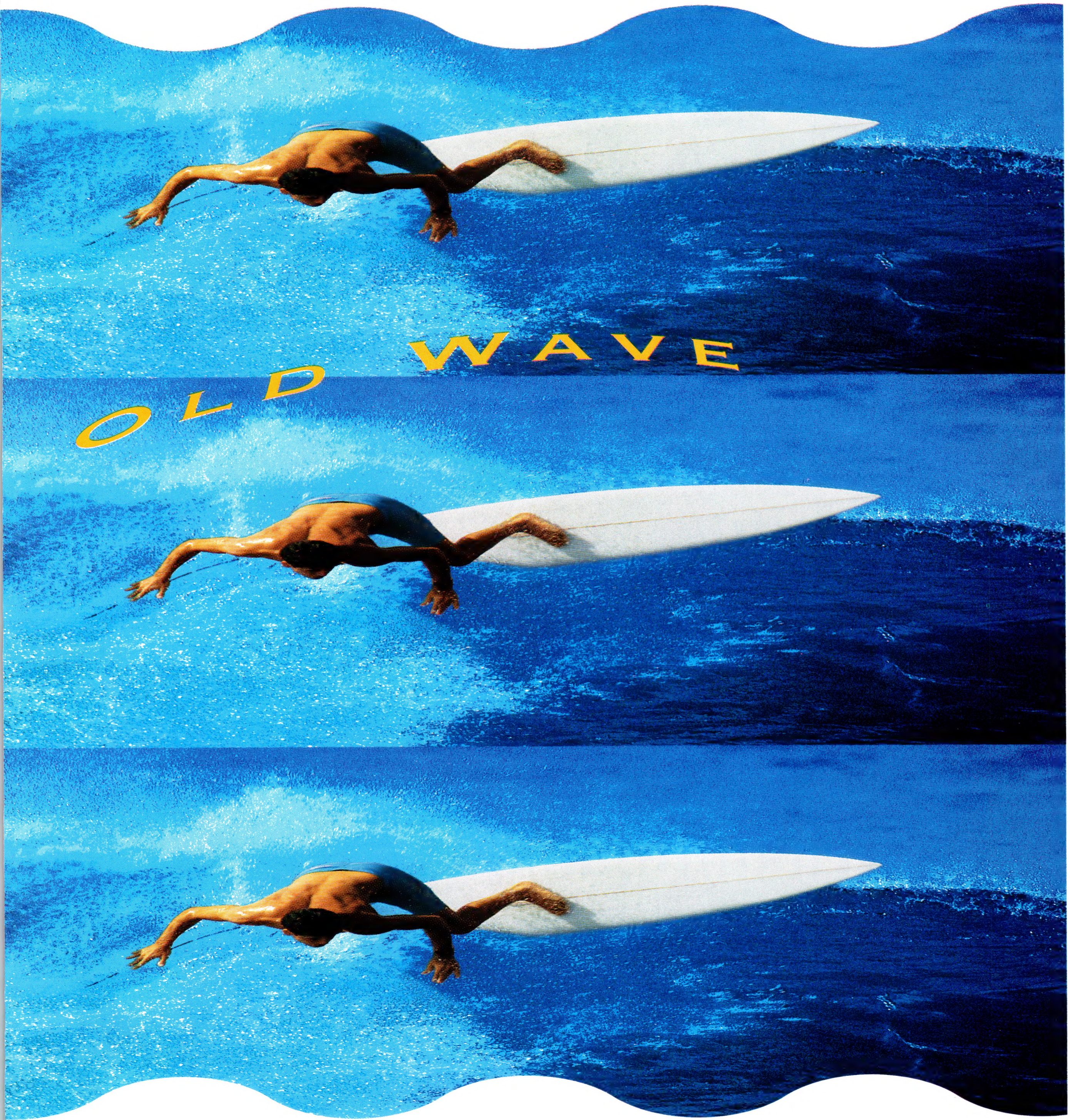

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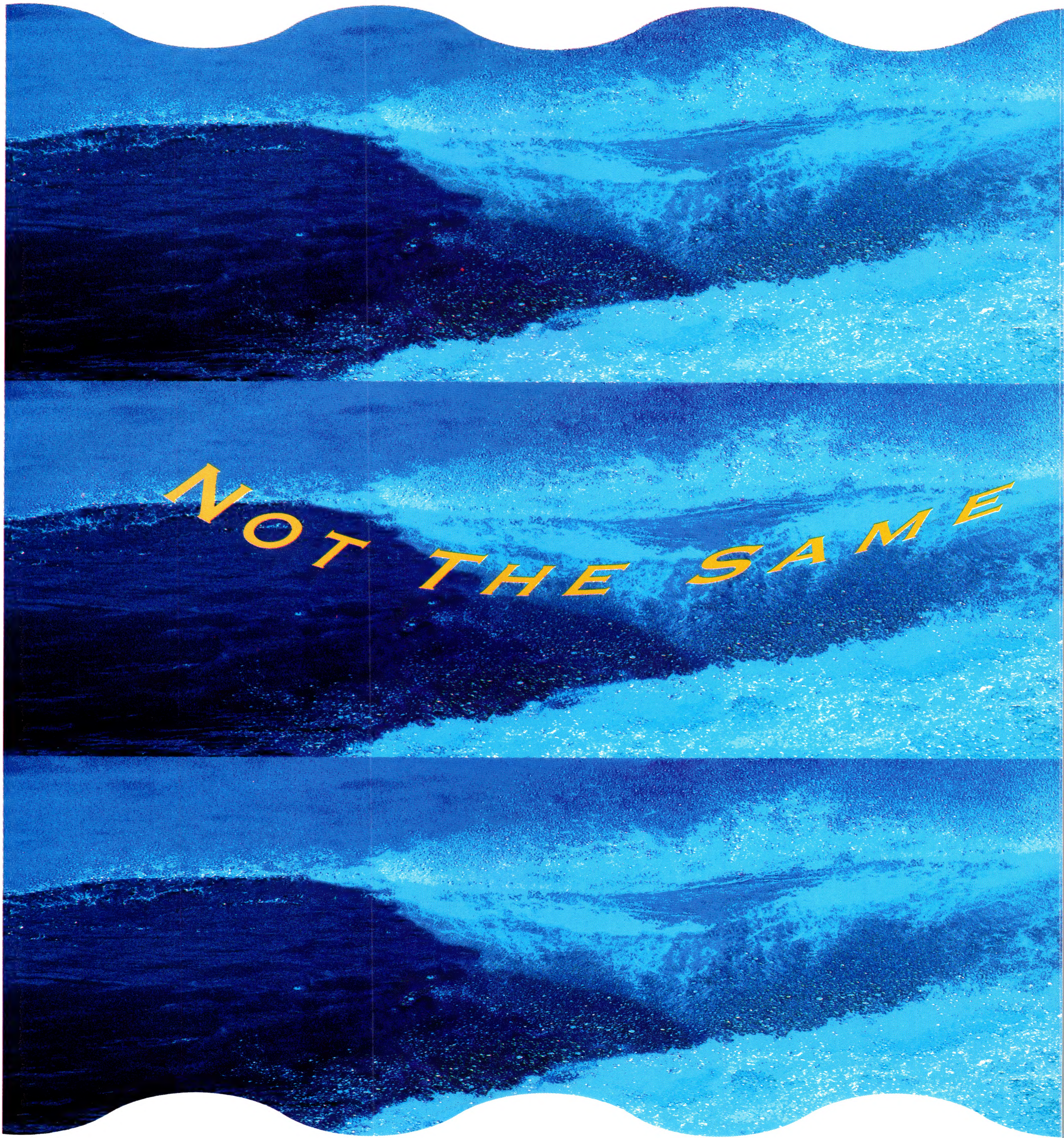

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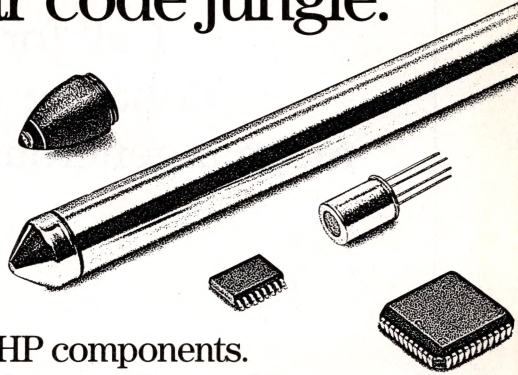

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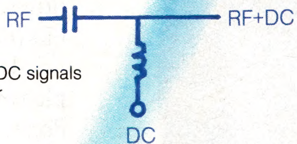

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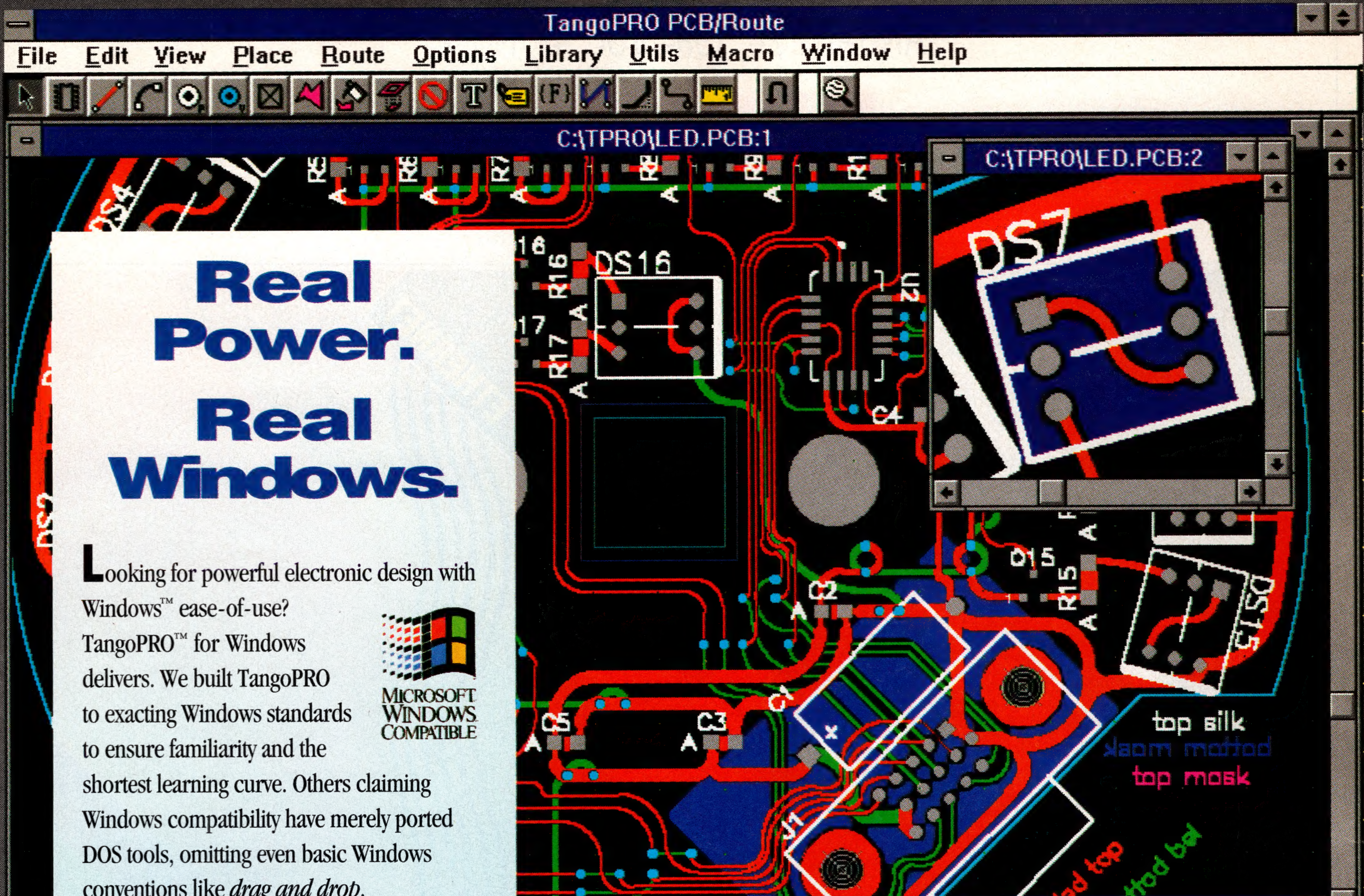

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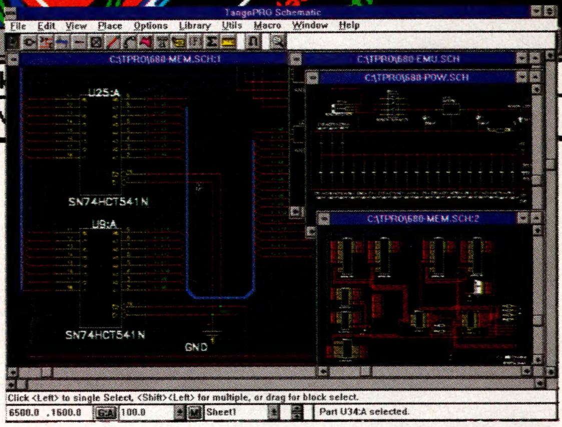

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ELECTRONIC DESIGN 40 YEARS AGO

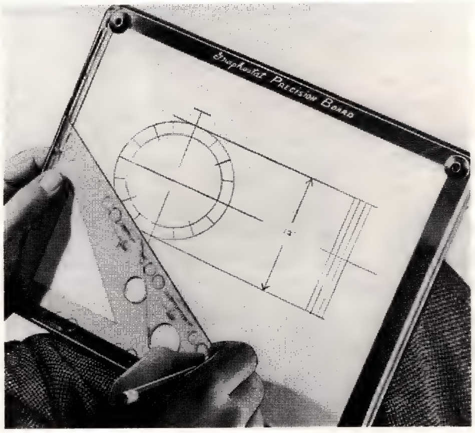
Circuit stories wanted

Certain portions of an electronic design project often are very interesting from a design point of view. Because these design innovations or circuit tricks are only part of a larger device they rarely get the attention they deserve, usually being buried in a complex circuit diagram or often tagged on the end of a long article as an afterthought. A number of readers have expressed an interest in this type of editorial material, and in keeping with their wishes such "circuit stories" are being solicited for early publication in Electronic Design.

The article should be brief, from 200 to 400 words long, and should tell the reader (1) what the circuit is, (2) how it works, and (3) where it can be used. The circuit diagram should be neatly drawn with all component values properly labeled. The drawing should be in black ink on 8-1/2" x 11" white paper or tracing cloth, with Leroy or standard engineering lettering large enough to permit reduction. A glossy photograph of the diagram is also acceptable. Payment of $10.00 will be made upon publication for each "circuit story" accepted. Manuscripts should be sent to the Editor, Electronic Design, 127 East 55th Street, New York 22, N.Y. *(Electronic Design, January 1954, p. 8.)*

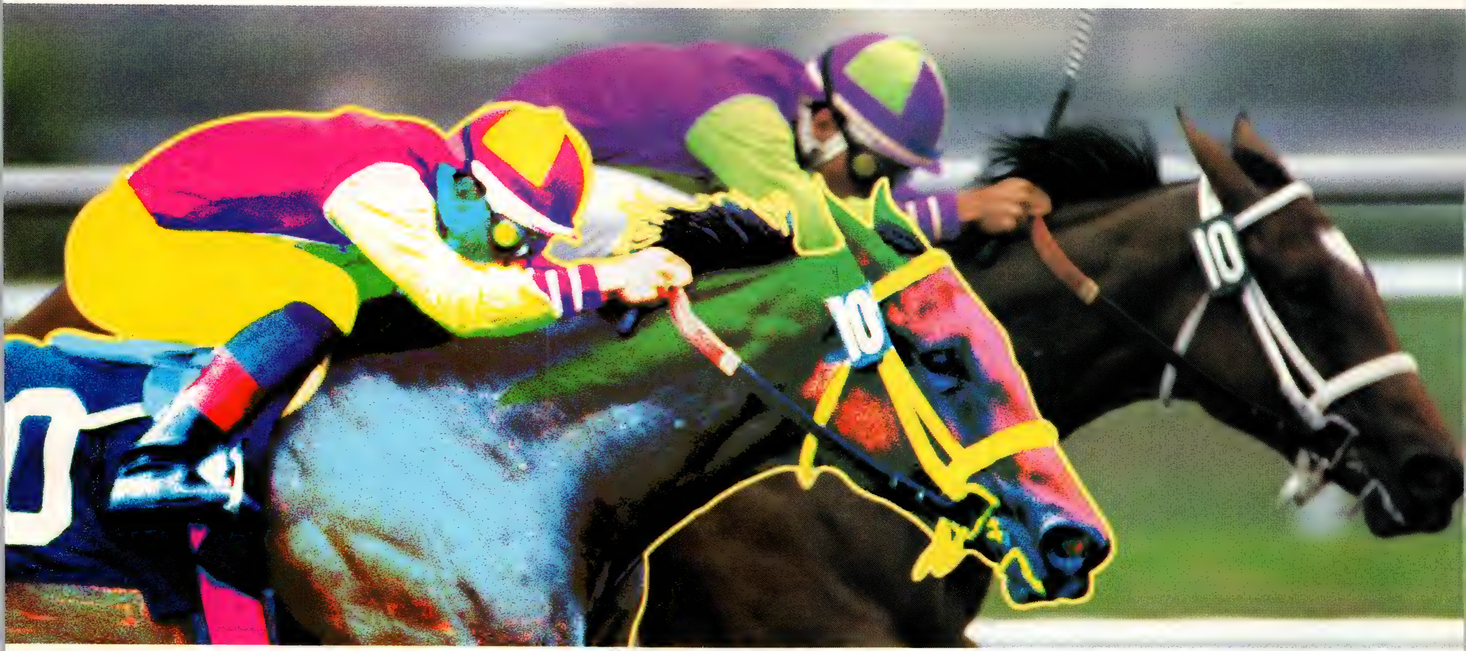
This appears to be the beginnings of Electronic Design's popular Ideas for Design section. Some of the advice still holds true today: text length of 200 to 400 words; the need to tell the reader what the circuit is; how it works; and where it can be used. However, the instructions on submitting drawings are quite outdated. Electronic Design's Art Department redraws all diagrams, so now we only ask for a clear rendering of the circuit, waveform, or performance curve. Even though the editors began asking for circuit ideas here in the January 1954 issue, the section only appeared sporadically through the next few years.—SS

Portable plastic drawing board



Molded of clear, durable, polystyrene plastic, the portable drawing board shown measures 9-3/4" x 12-1/4" and weighs only 8 oz. It can be slipped easily into a brief case or be kept in a drawer for making design drawings in the field or at the desk. The board is provided with four corner clamps that hold 8-1/2" x 11" paper without thumb tacks or adhesive tape. The clamps are recessed into the plastic so that a ruler or triangle can ride freely over them without interference. Two recessed metal straight edges, one along the bottom edge and the other along the left edge, make it possible to make precision drawings without a T-square. By pushing the lower end of the vertical straight edge slightly upward, the entire metal strip snaps up above the level of the drawing board from its recessed position. The horizontal straight edge is raised by pushing one end slightly to the right. In the raised position, the strips serve as guides for a triangle in drawing parallel lines, for cross-hatching, etc. Tension clips on the under side of the board are provided for storing two 8" triangles. The compact size and light weight of the board make it especially useful as a lap drawing board. *(Electronic Design, January 1954, p. 24.)*

Today's personal digital assistants had nothing on the portable design aids of 40 years ago. Note that this design aid required no batteries and could be operated on an airplane without fear of interfering with the plane's RF systems. You didn't have to read any tangled-English instruction book, and it had a nonvolatile, archival-quality memory for data storage (paper). And whereas today's PDAs are just getting to a pen input, this one had it 40 years ago.—SS



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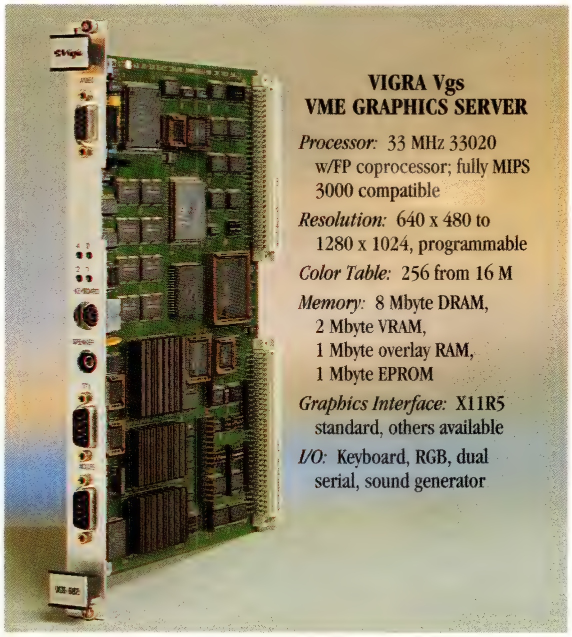

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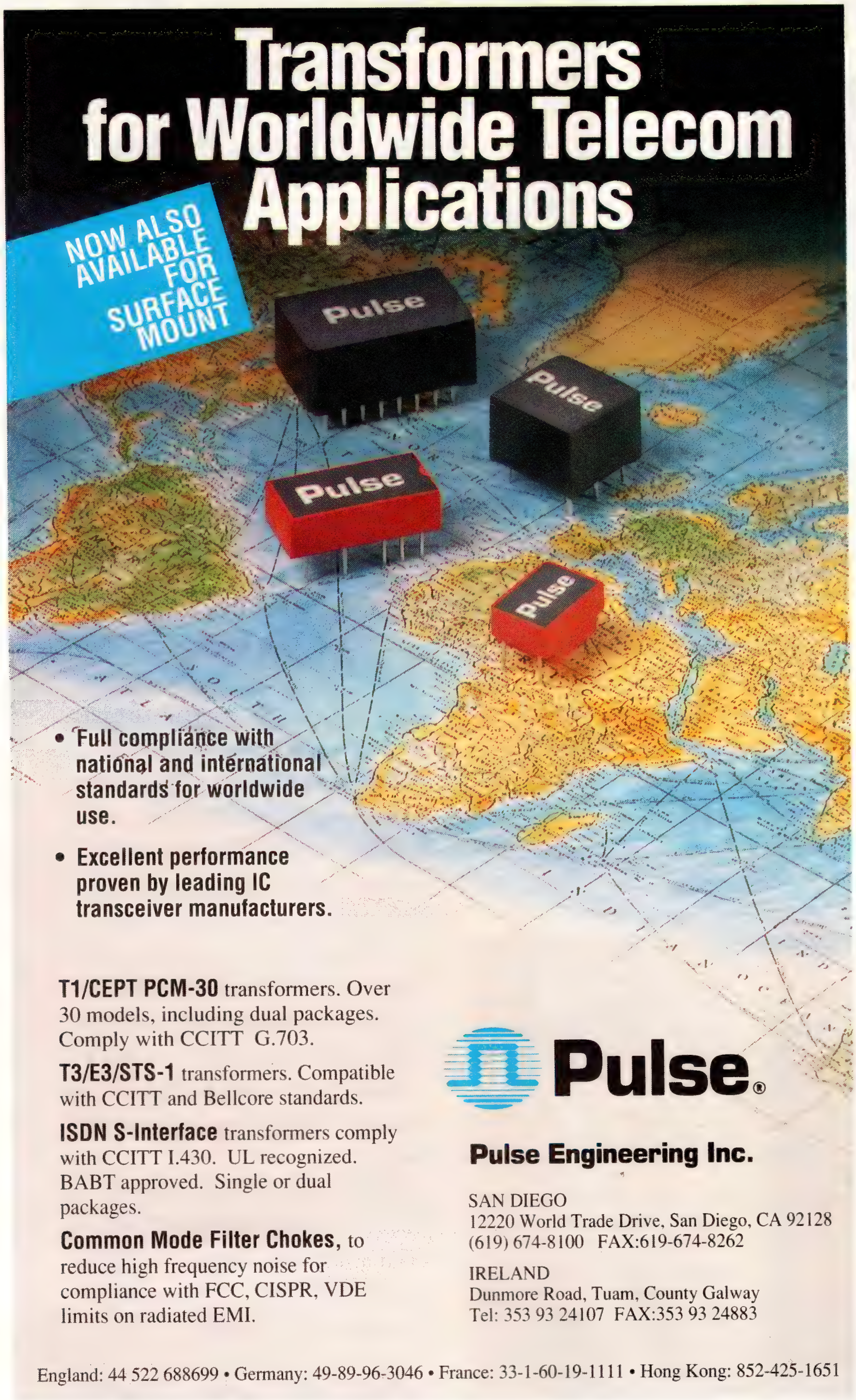

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UPCOMING MEETINGS

JANUARY

ComNet '94 Conference, Jan. 24-27. Washington Convention Center, Washington D.C. Contact ComNet '94, P.O. Box 3500-83, Boston, MA 02241-0583; (800) 225-4698.

1994 Annual Reliability and Maintainability Symposium, Jan. 25-27. Anaheim Marriott Hotel, Anaheim, CA. Contact V.R. Monshaw, Consulting Services, 1768 Lark Ln., Cherry Hill, NJ 08003; (609) 428-2342.

1994 IEEE Power Engineering Society Winter Meeting, Jan. 30-Feb. 3. New York Hilton & Towers, New York, NY. Contact Frank E. Schink, 14 Middlebury Ln., Cranford, NJ 07016-1622; (908) 276-8847.

FEBRUARY

1994 IEEE 2nd CAD-Based Vision Workshop, Feb. 8-10. Seven Springs Mountain Resort, Champion, PA. Contact IEEE Computer Society Conference Dept., 1730 Massachusetts Ave., N.W., Washington D.C. 20036-1992; (202) 371-1013.

1994 IEEE Applied Power Electronics Conference and Exposition, Feb. 13-17. Walt Disney World Resort, Orlando, FL. Contact Pamela Wagner, Courtesy Associates, 655 15th St., S.W., Suite 300, Washington D.C. 20005; (202) 639-4990.

1994 IEEE 10th International Conference on Data Engineering, Feb. 14-18. Double Tree Hotel, Houston, TX. Contact IEEE Computer Society Conference Dept., 1730 Massachusetts Ave. N.W., Washington D.C. 20036-1992; (202) 371-1013.

1994 IEEE Network Operations and Management Symposium (NOMS '94), Feb. 14-18. Hyatt Orlando Hotel, Orlando, FL. Contact Jill Pancio, Pacific Bell, Room 100, 7620 Convoy Ct., San Diego, CA 92111; (619) 268-6135.

Portable by Design Conference & Exposition, Feb. 14-18. Santa Clara Convention Center, Santa Clara, CA. Contact Betsy Tapp, *Electronic Design* magazine, 611 Rte. 46 West, Hasbrouck Heights, NJ 07604; (201) 393-6075.

Wireless Symposium & Exhibition, Feb. 15-18. Santa Clara Convention Center, Santa Clara, CA. Contact Jack Browne, *Microwaves & RF* magazine, 611 Rte. 46 West, Hasbrouck Heights, NJ 07604; (201) 393-6293.

1994 IEEE International Solid State Circuits Conference (ISSCC), Feb. 16-18. San Francisco Marriott Hotel, San Francisco, CA. Contact Diane Suiters, Courtesy Associates, 655 15th St., N.W., Suite 300, Washington D.C. 20005; (202) 639-4255.

1994 Conference on Optical Fiber Communication (OFC '94), Feb., 20-25. San Jose Convention Center, San Jose, CA. Contact IEEE/LEOS, 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08855-1331; (908) 562-3893.

Microsoft Windows Hardware Developers Conference, Feb. 23-25. Moscone Convention Center, San Francisco, CA. Contact Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052; (800) 541-1261.

NEPCON West '94 Conference & Exposition, Feb. 27-Mar. 4. Anaheim Convention Center, Anaheim, CA. Contact NEPCON West '94, P.O. Box 552, Brookfield, IL 60513-0552; (708) 390-2420.

MARCH

IEEE COMPCON '94, Mar. 1-3. Stanford Court Hotel, San Francisco, CA, Contact Theodore Laliotis, Hewlett-Packard Laboratories, 1501 Page Mill Rd., Palo Alto, CA 94304; (415) 857-8750; (E-mail) Laliotis@hpl.hp.com.

1994 IEEE Symposium on Computer-Aided Control Systems Design (CACSD), Mar. 7-9. Tucson Convention Center, Tucson, AZ. Contact Professor Paul Battes, Engineering Professional Development, P.O. Box 9, Harvill Bldg., University of Arizona, Tucson, AZ 85721; (602) 621-5104.

mobile94 Conference & Exposition, Mar. 7-10. San Jose Convention Center, San Jose, CA. Contact Technologic Partners, 419 Park Ave. S., New York, NY 10016; (800) 326-3613.

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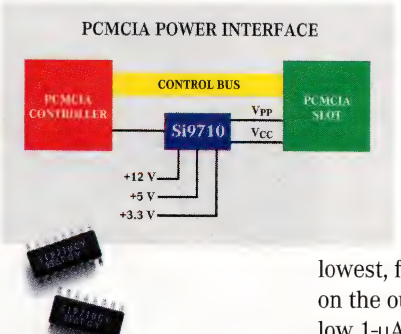

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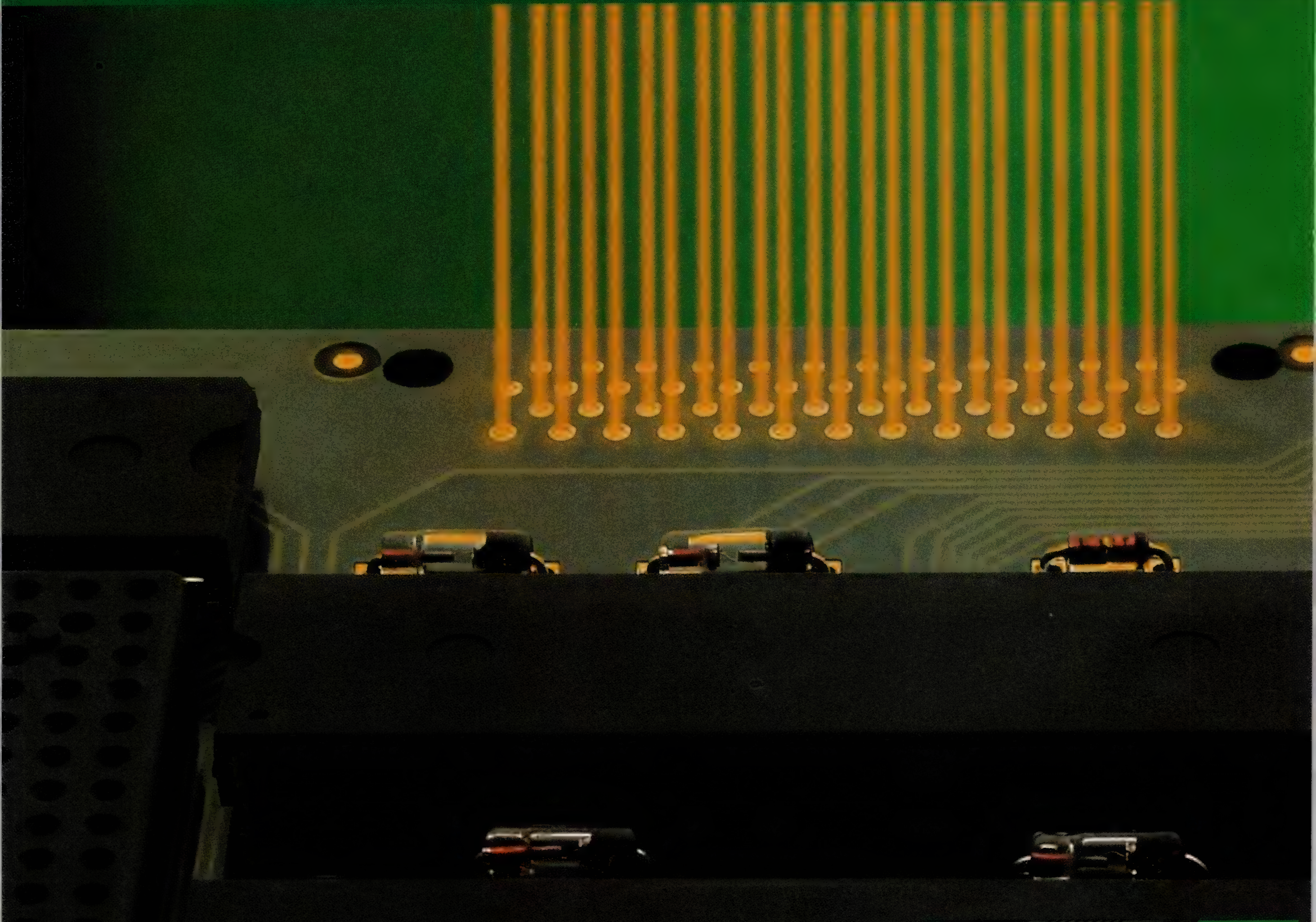

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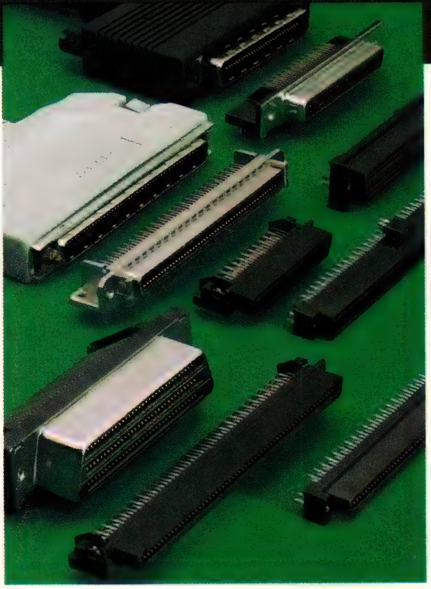

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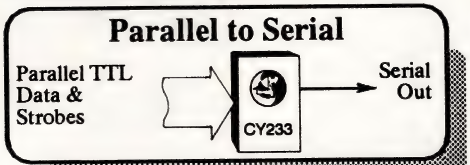

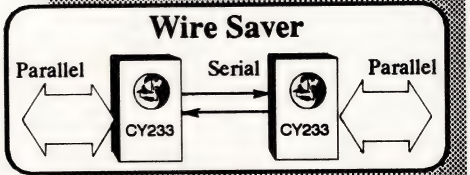

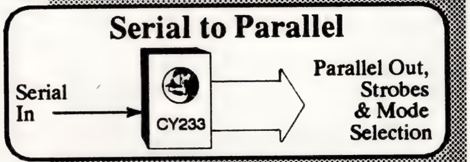

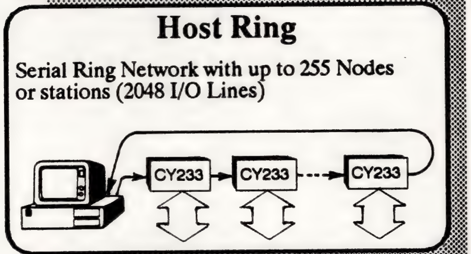
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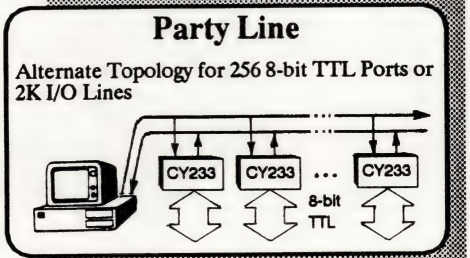

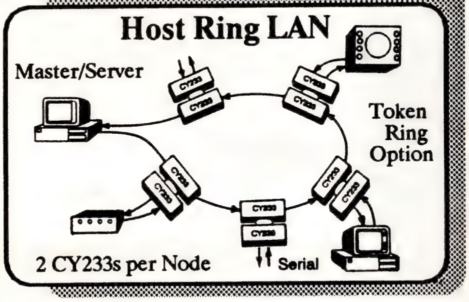

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EDITORIAL

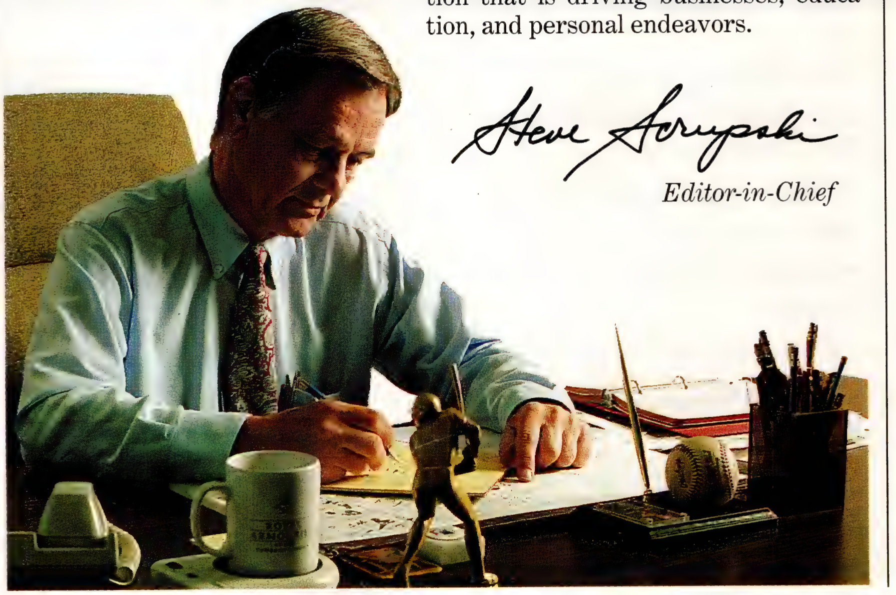
LET THE COMPETITION BEGIN

For all those who have supported free enterprise and competition as the catalyst for advancing technology, the move by the Clinton administration to lift restrictions on competition between telephone companies and cable television operators is welcome. We're entering a new era in communications with a panorama of services in the offing; these will likely give average citizens access to unprecedented amounts of information of every sort. As we see it, the only proper course for the government is to get out of the way and let the marketplace pick the winners and losers. We don't need artificial restrictions that are holdovers from decades-old policies.

Consider the mail, for example. At one time we relied on the U.S. Postal Service to carry all our letters and packages. Today, however, everything operates at a much faster pace and our transportation facilities reflect that, with more emphasis on transport by air. As a result, to send an important package from East to West Coast as fast as possible, we have a host of competitors offering specialized delivery services to pick from—Federal Express, DHL, United Parcel Service, Airborne Express, and others. Because of this competition, the Postal Service not only offers overnight delivery but has improved services overall. Would any of us want to return to the old days?

When Vice President Al Gore began talking about the "national information infrastructure" early last year, as much as we applauded the administration's recognition of the emerging technology, we still were uneasy about the possibility of strong government involvement in managing the infrastructure. The technology is changing too rapidly, with trade-offs changing with each new development, for any entity as static and vulnerable to special-interest bias as the federal government to run the emerging system. Let's hope that this is only the first of many moves by the government to help open up competition in the marketplace, at home and abroad.

Just as important, free competition in communications services should not result in favoritism toward well-heeled customers. We do need government involvement in one aspect of communication policy: to ensure fair access to the new types of communications services to all citizens and businesses, just as it monitors fair usage of the electromagnetic spectrum. In the case of the telephone, phone companies—to their credit—eventually provided and maintained service in remote rural areas as well as in densely populated, high-traffic areas. Today, information is power, and it becomes more critical as more of our economy shifts to a service base. All citizens must have access to the information that is driving businesses, education, and personal endeavors.



Steve Scrupski
Editor-in-Chief

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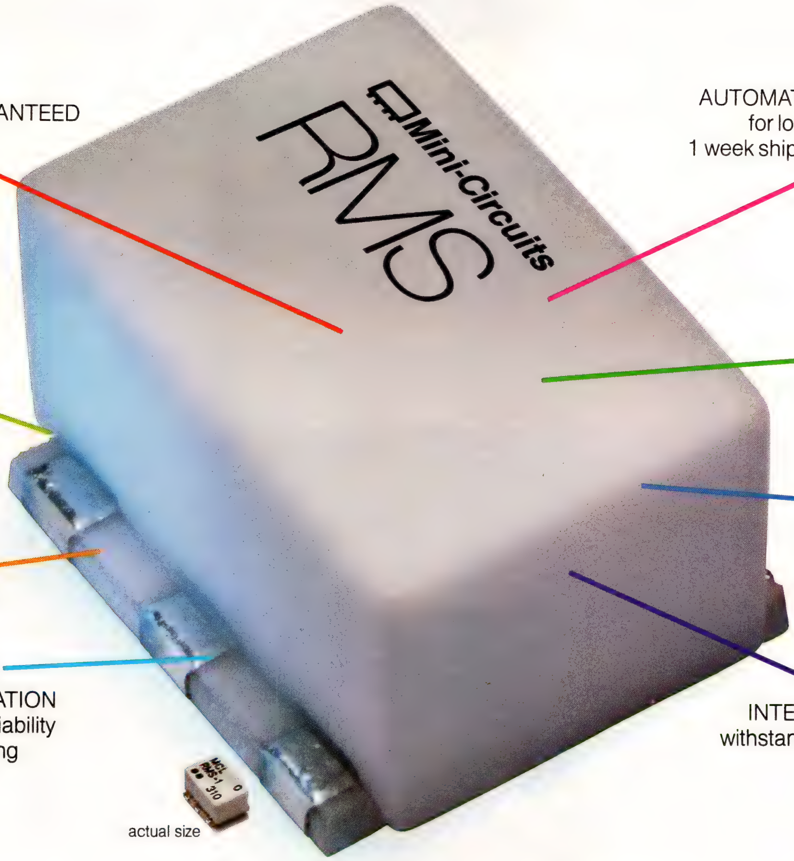

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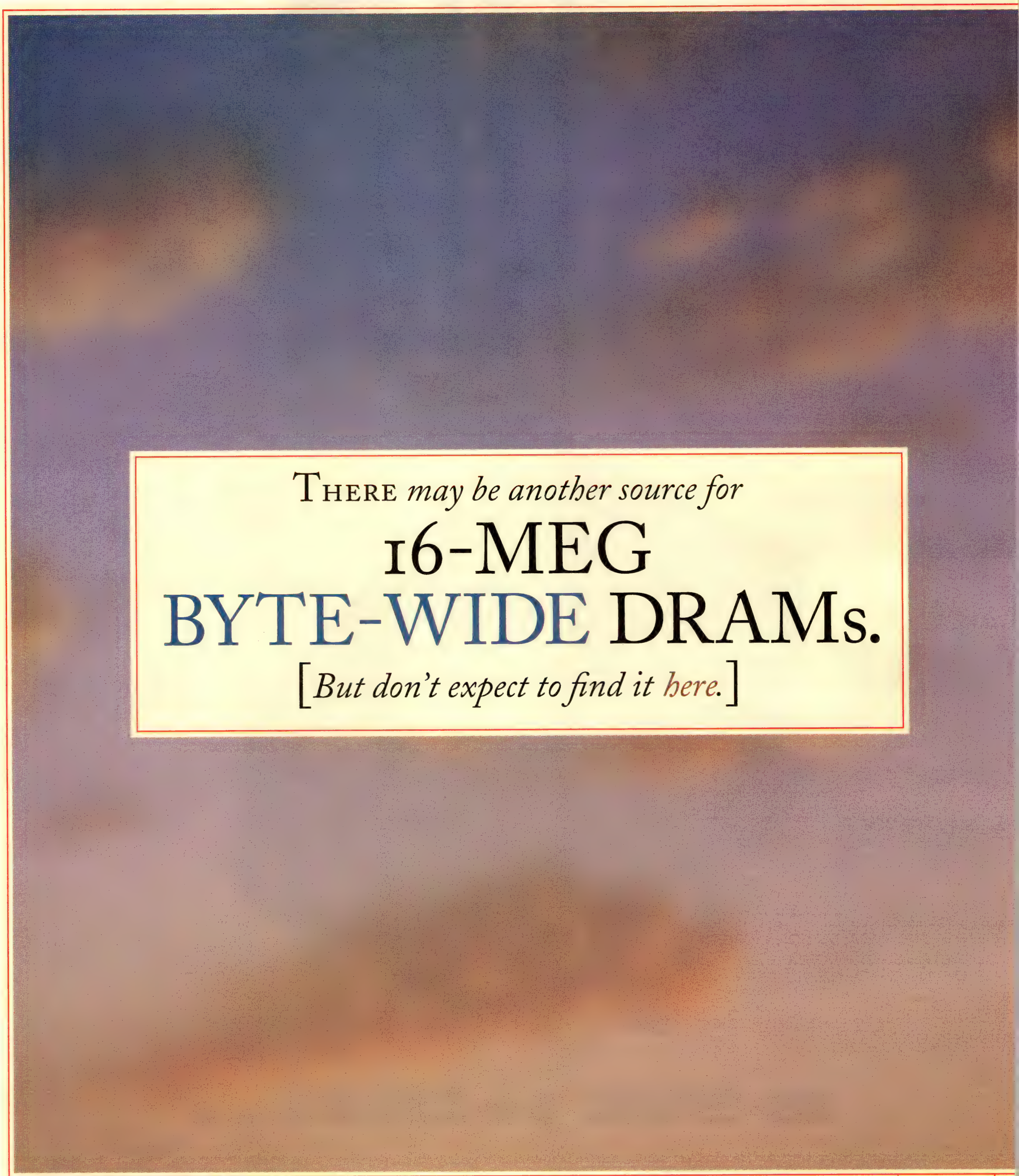

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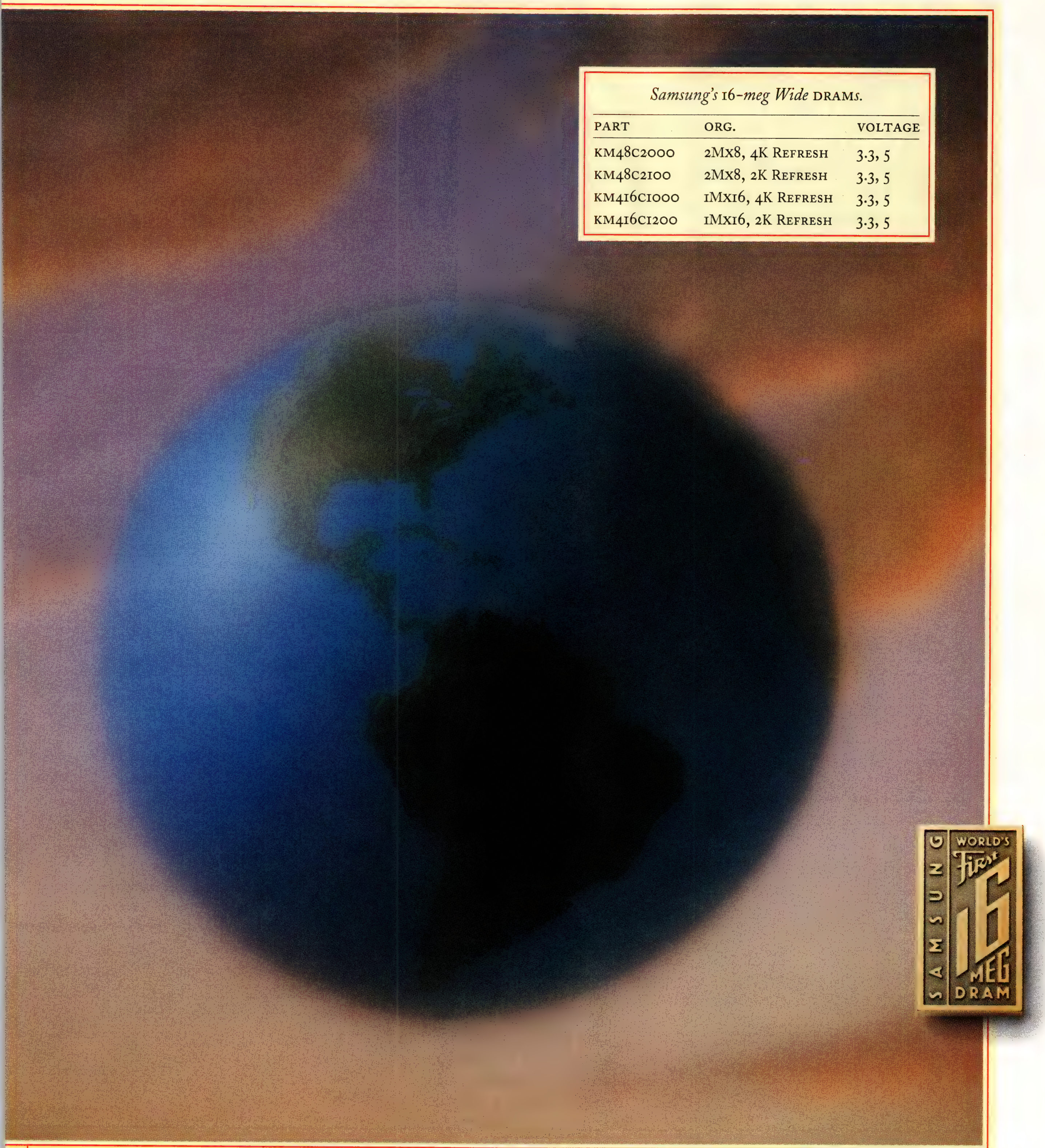

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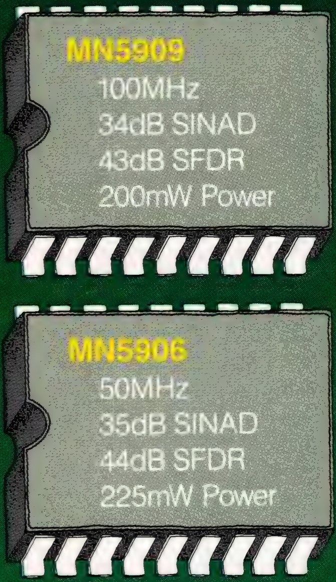

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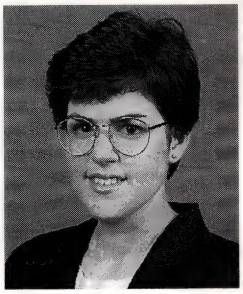
VHDL MOVES BEYOND SIMULATION

In *Electronic Design*'s 1993 EDA survey, almost 25% of the respondents indicated they use VHDL in their design cycle. While that survey simply asked if engineers were adopting VHDL, the results of another recent survey from VHDL International (VI) Inc., Menlo Park, Calif., revealed some interesting trends on how the language is permeating the design community. Most importantly, the survey showed that VHDL is moving beyond simulation, which up to now has been its primary application, and into other phases of the design cycle.

VI conducted the survey to focus its efforts on helping the user community get more value out of VHDL and the respective tools. The survey, which is to become an annual event, focused on identifying issues and concerns when using VHDL. The results show that VHDL is finding its way into more of the design process and that users are generally pleased with the quality of existing tools. However, the results also uncovered some issues that still must be overcome.

The survey consisted of 26 questions that were distributed to 4000 VI members in the design community. To get a balanced cross section of VHDL users, the targeted survey list was based on members from Europe, Japan, and the U.S. Approximately 400 responses were logged, with 25% of the responses coming from overseas.

The results highlighted some interesting facts about the evolving VHDL market. For example, 71% of the respondents said that they're currently using multiple VHDL tools in their design environment, which indicates that VHDL is being used in multiple phases of the design process. All of the respondents indicated that they use VHDL for simulation, and 76% said they use VHDL for synthesis. That means roughly three-quarters of VHDL users employ some form of top-down design, which exploits the language's inherent high-level descriptive capabilities.


LISA MALINIAK
COMPUTER-AIDED ENGINEERING

In general, those using VHDL tools are satisfied with their products. Actually, 82% of the users indicated that tool quality is good to excellent. The remaining 18% responded that tool quality is fair or poor.

A number of other issues were also identified. For instance, 90% of the respondents felt that ASIC design support in VHDL was either critical or very important, while 87% indicated that support for ASIC libraries was either critical or very important. The lack of good libraries for VHDL-based design has plagued users from the start. To address this issue, VHDL International is continuing to support and work with the VITAL initiative, an organization working for the adoption of a VHDL-based ASIC modeling standard.

System design with VHDL was also highlighted in the survey. For 89% of the respondents, system-design capability in VHDL is either critical or very important. These findings imply that the design community is viewing VHDL in the context of a broad design solution.

Tool compatibility also continues to be a concern among VHDL users. More specifically, 90% of the responses indicated that the ability to move VHDL-based designs between different tools was either critical or very important. This finding gives additional support to VI's current project to develop a standard VHDL test suite. The suite will give users a tool for relative measurements of tool adherence to the VHDL language standard.

VI compiled a summary of the report statistics that's available to the public through the VHDL International Internet Services (VIIS). Those interested in obtaining the summary can do so by sending the E-mail message "send vi/survey result93.txt" to "archive@vhdl.org." VI corporate members may receive all details of the survey by contacting the VI office. For more information, call (800) 554-2550 or (415) 329-0578.

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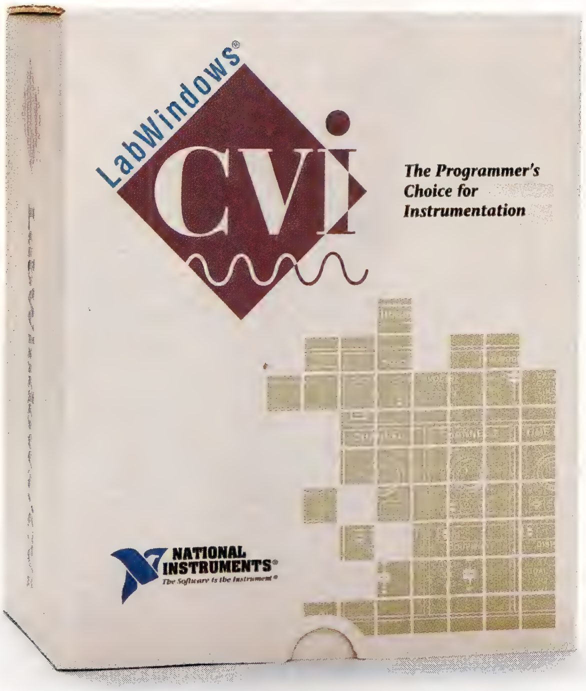
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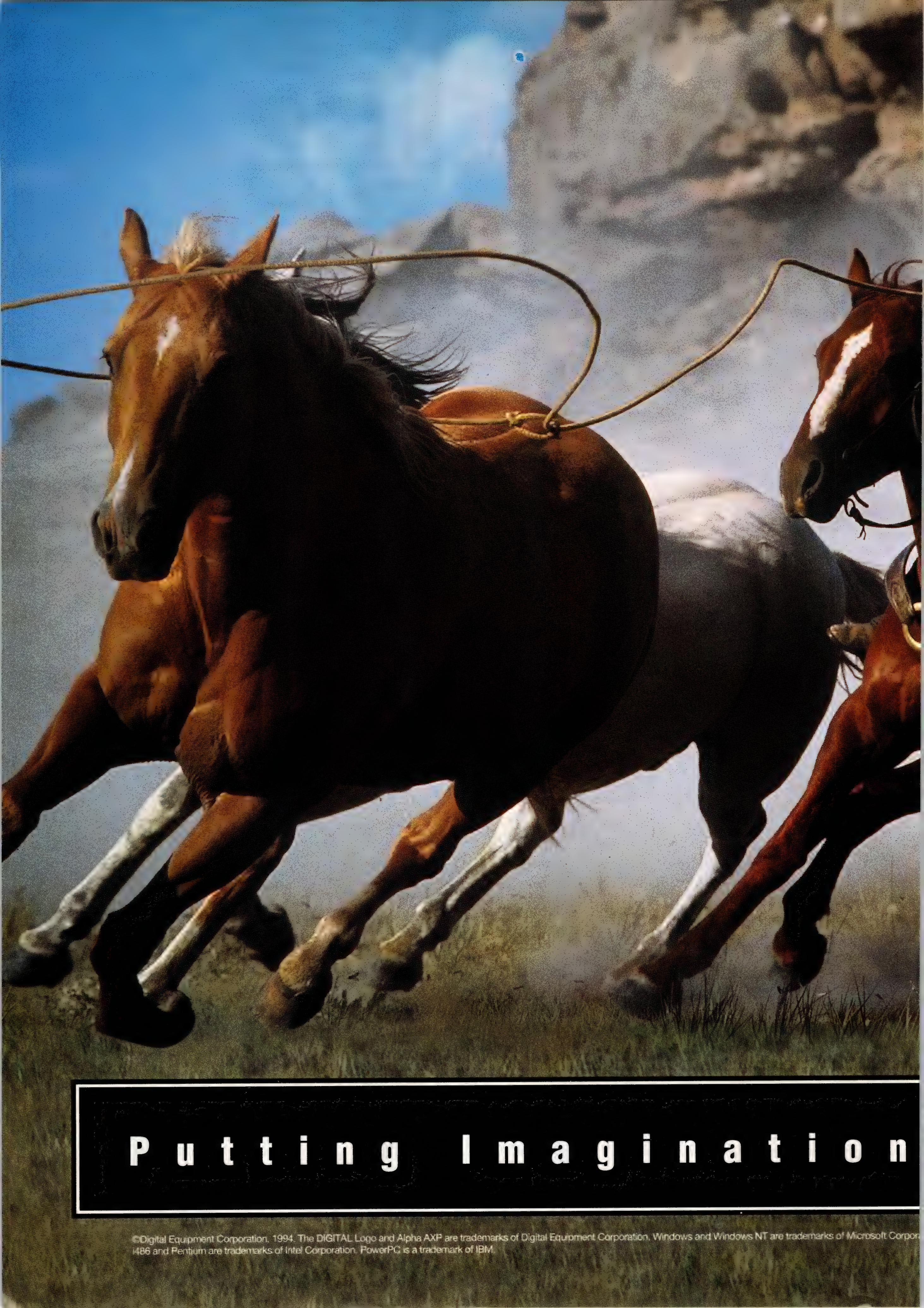

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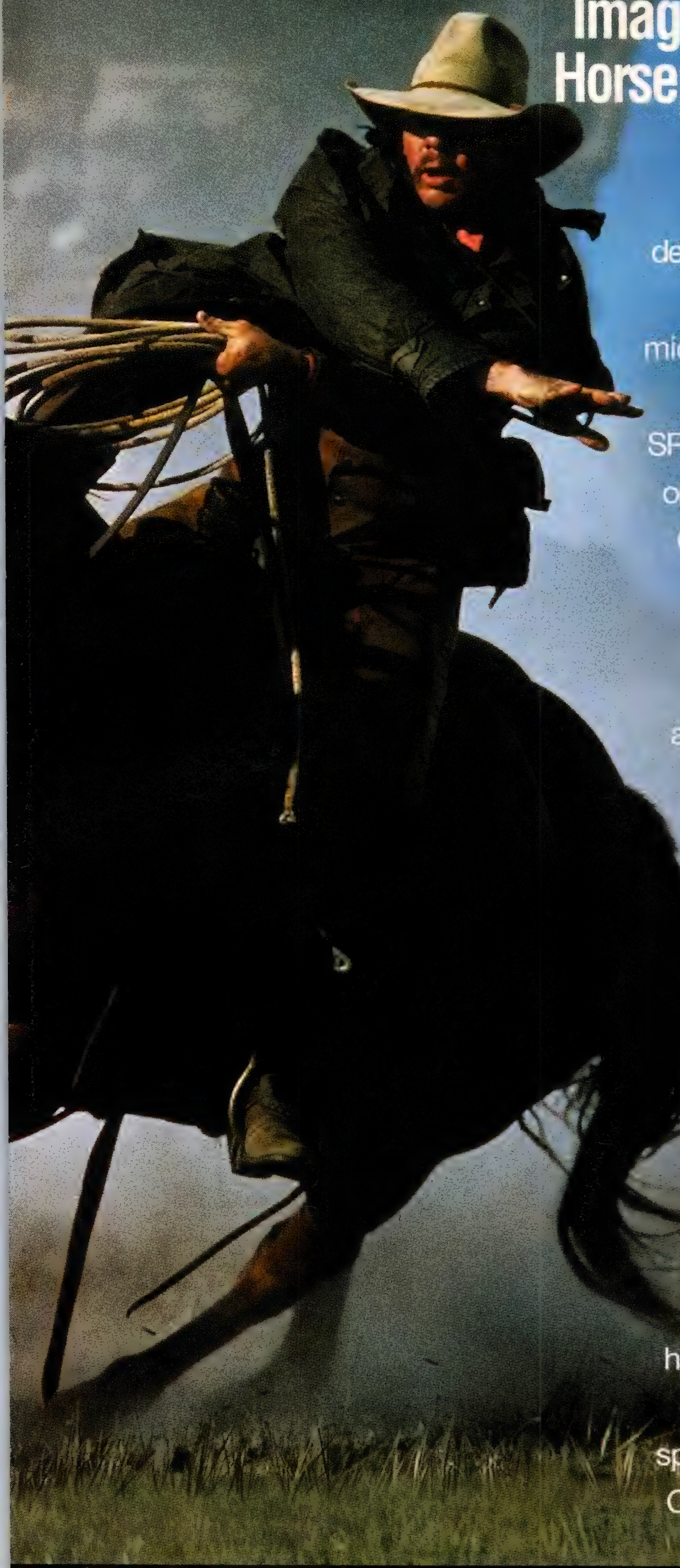

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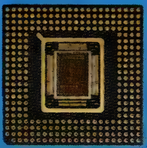

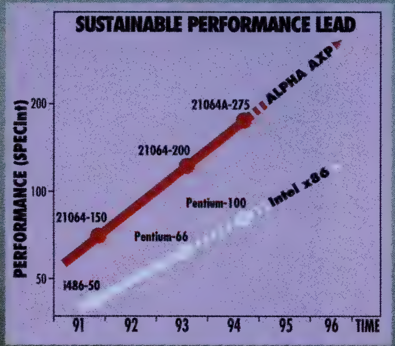

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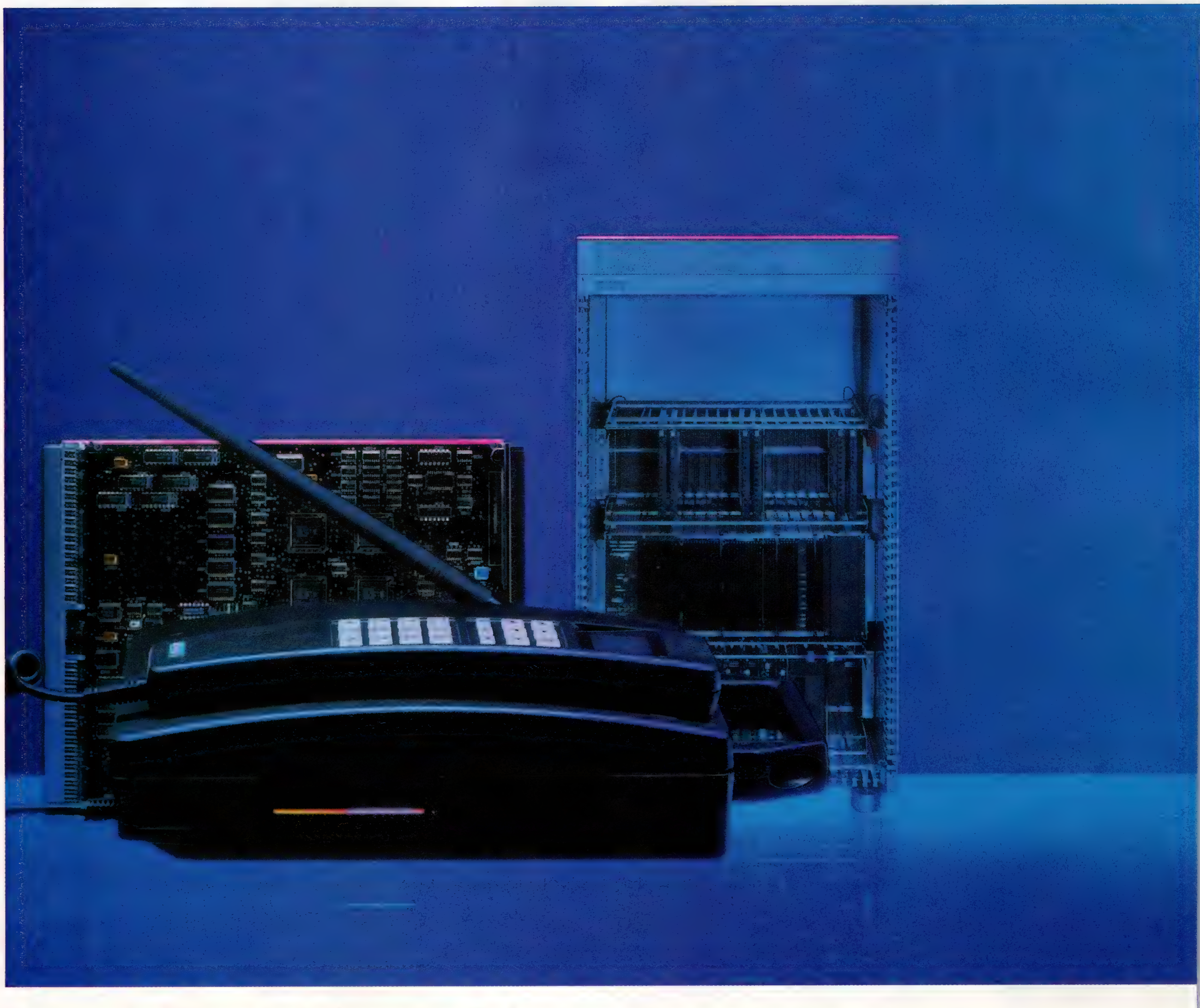

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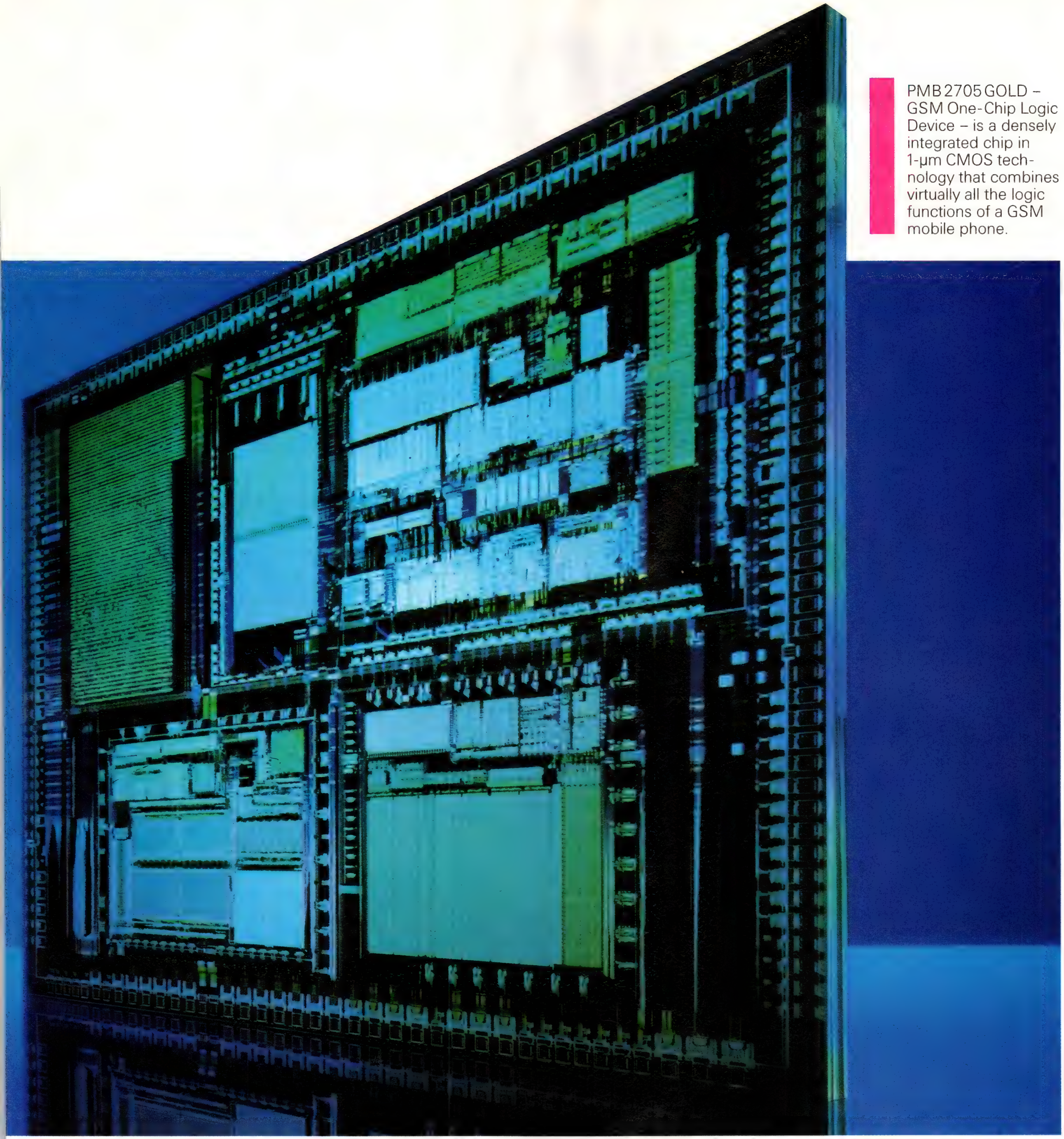

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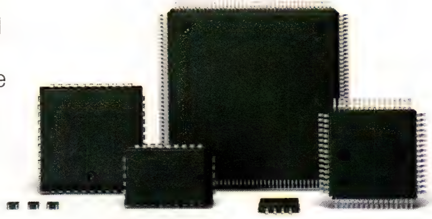

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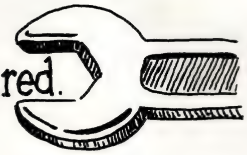
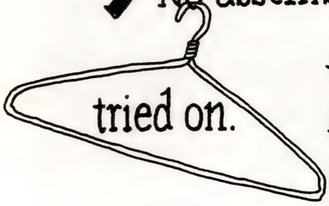
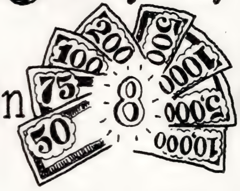
10 They don't require batteries.

9 No assembly required.  **8** They don't need to be  tried on. **7** You can send them anywhere without having to pack them in big, brown boxes filled with .

6 They only come in one color. **5** They're available in  denominations.

4 Even if they already have one, they'll certainly appreciate another. **3** They make you look like a bigger spender than you really are. **2** They won't be out of style before they arrive. **1** People ALWAYS remember the people who give them Savings Bonds.

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TECHNOLOGY NEWSLETTER

ASEM PROJECT TARGETS MCM TEST TOOLS

Multichip modules (MCMs) should become easier to test, diagnose, and repair as the result of work being done under the Application-Specific Electronic Module (ASEM) MCM infrastructure program. E-Systems Inc.'s Greenville Div., Greenville, Texas, recently awarded a $1.5 million contract to Teradyne Inc.'s Assembly Test Group, Boston, to develop boundary-scan design and test tools. The ASEM program, sponsored by the U.S. Department of Defense's Advanced Research Projects Agency (ARPA), aims at promoting a commercial infrastructure that will improve design, manufacturing, and testing of MCMs. E-Systems is the prime contractor for an ASEM program targeting design and test tools. The contract could grow to $4.8 million if all options are exercised. Under the contract, Teradyne will extend its Victory boundary-scan software to commercially available ATE from other manufacturers. The company will develop technology to allow Victory's Virtual Interconnect and Virtual Component/Cluster Test modules to generate test programs that will run on other testers. Also, a test-independent architecture will be created to support automated boundary-scan diagnostics on non-Teradyne testers. According to Walter Vahey, Victory product manager, "Development of these tools will not only allow MCMs to be diagnosed and repaired, but will also provide feedback to the manufacturing process to improve yields and lower costs." *JN*

SPEC UPDATES STANDARDS FOR DEVELOPMENT TOOLS

Version 1.1 of the Tool Interface Standards (TIS) Portable Formats specification was released by the TIS committee. The committee consists of various companies working to advance the portability and interoperability of application development tools for 32-bit Intel architecture operating environments. Version 1.1 includes updates to the relocatable object module format (OMF) and Dwarf debugging standards. In addition, it clarifies any remaining inconsistencies in the OMF standard. Changes to the Dwarf standard enable support for additional languages, including C++, Fortran 90, Modula2, and Pascal, and denser encoding of the Dwarf debug information. For a copy of the TIS standard, contact Intel's Literature Dept. at (800) 548-4725 and request order number 241597. Interested parties can also download the TIS Portable Formats specification from Compuserve's Intel Access forum. *RN*

USAF SENSOR PROJECT TARGETS THREAT WARNING

A research project is setting its sights on a sensor system that would ultimately be embedded in an aircraft's skin and fulfill both threat-warning and fire-control needs. Irvine Sensors Corp., Costa Mesa, Calif., received a 22-month, $780,000 contract from the U.S. Air Force Wright Laboratory's Avionics Directorate to develop sensors using a new approach called multimode optical search and track (MOST). The sensors will rely on Irvine Sensors' proprietary Dynamic Stare technology, in addition to a new technique for real-time integration of clusters of distributed sensors. Typically, these clusters would have differing fields of view, frame rates, and resolutions. The sensor system would, in effect, rapidly shift its focus to whatever was of immediate interest by electronically switching back and forth from one cluster to another. Under the Air Force contract, Irvine Sensors will demonstrate the electronics necessary to achieve real-time digitization, integration, and processing of such diverse inputs at the pixel level. The ability to process data at the pixel level before it leaves the sensor focal plane is the key to simultaneously processing the wide field-of-view imagery necessary for threat warning and the narrow field-of-view of search and track functions. The technology, which Irvine Sensors calls Hyperpixel imagery, has potential for commercial applications in such diverse fields as process monitoring, gas detection, robotics vision, spectroscopy, and medical imaging, among others. Call Irvine Sensors at (714) 549-8211 for more information. *DM*

STACKED RAMS SHRINK SOLID-STATE RECORDERS

In another effort, Irvine Sensors along with Lockheed Sanders Inc., Nashua, N.H., has set up a development project to create memory short stacks—high-density memory blocks. Each block consists of up to ten memory chips thinned down to a fraction of their original thickness. The blocks are then bonded together to form a "virtual" memory chip that can fit into the space of one IC. The stacks will be used in solid-state data recorders for airborne and space applications, where a high reliability level, very small size, light weight, and low power are desired. The stacks are said to offer capacities

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- VSWR less than 1.7 (typ)
- rugged hermetically-sealed pin models
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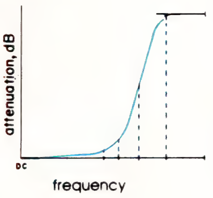
LOW PASS



low pass, Plug-in, dc to 1200MHz

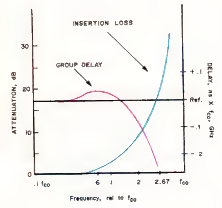
Model No.	Passband MHz loss < 1dB	Stopband, MHz loss > 20dB	Stopband, MHz loss > 40dB
★LP-5	DC-5	8-10	10-200
★LP-10.7	DC-11	19-24	24-200
★LP-21.4	DC-22	32-41	41-200
★LP-30	DC-32	47-61	61-200
★LP-50	DC-48	70-90	90-200
★LP-70	DC-60	90-117	117-300
★P-90	DC-81	121-137	167-400
★LP-100	DC-98	146-189	189-400
★LP-150	DC-140	210-300	300-600
★LP-200	DC-190	290-390	390-800
★LP-250	DC-225	320-400	400-1200
★LP-300	DC-270	410-550	550-1200
★LP-450	DC-400	580-750	750-1800
★LP-550	DC-520	750-920	920-2000
★LP-600	DC-680	840-1120	1120-2000
★LP-750	DC-700	1000-1300	1300-2000
★LP-800	DC-720	1080-1400	1400-2000
★LP-850	DC-760	1100-1400	1400-2000
★LP-1000	DC-900	1340-1750	1750-2000
★LP-1200	DC-1000	1620-2100	2100-2500

Price, (1-9 qty), all models: plug-in $14.95, BNC $32.95, SMA $34.95, Type N $35.95

Surface-mount, dc to 570MHz

SCLF-21.4	DC-22	32-41	41-200
SCLF-30	DC-30	47-61	61-200
SCLF-45	DC-45	70-90	90-200
SCLF-135	DC-135	210-300	300-600
SCLF-190	DC-190	290-390	390-800
SCLF-380	DC-380	580-750	750-1800
SCLF-420	DC-420	750-920	920-2000

Price, (1-9 qty), all models: $11.45

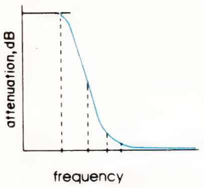


Flat Time Delay, dc to 1870MHz

Model No.	Passband MHz loss < 1.2dB	Stopband MHz loss > 10dB	Stopband MHz loss > 20dB	VSWR Freq. Range, DC thru 0.2fco X̄	VSWR Freq. Range, DC thru 0.6fco X̄	Group Delay Variations, ns Freq. Range, DC thru fco X̄	Group Delay Variations, ns Freq. Range, DC thru 2fco X̄	Group Delay Variations, ns Freq. Range, DC thru 2.67fco X̄
★BLP-39	DC-23	78-117	117	1.3:1	2.3:1	0.7	4.0	5.0
★BLP-117	DC-65	234-312	312	1.3:1	2.4:1	0.35	1.4	1.9
★BLP-156	DC-94	312-416	416	0.3:1	1.1:1	0.3	1.1	1.5
★BLP-200	DC-120	400-534	534	1.6:1	1.9:1	0.4	1.3	1.6
★BLP-300	DC-180	600-801	801	1.25:1	2.2:1	0.2	0.6	0.8
★BLP-467	DC-280	934-1246	1246	1.25:1	2.2:1	0.15	0.4	0.55
▲BLP-933	DC-560	1866-2490	2490	1.3:1	2.2:1	0.09	0.2	0.28
▲BLP-1870	DC-850	3740-6000	5000	1.45:1	2.9:1	0.05	0.1	0.15

Price, (1-9 qty), all models: plug-in $19.95, BNC $36.95, SMA $38.95, Type N $39.95
NOTE: ▲: -933 and -1870 only with connectors, at additional $2 above other connector models.

HIGH PASS

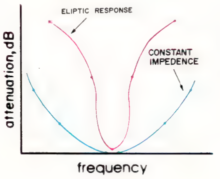


high pass, Plug-in, 27.5 to 2200MHz

Model No.	Stopband MHz loss < 40dB	Stopband MHz loss < 20dB	Passband, MHz loss < 1dB	VSWR Passband Typ.
★HP-25	DC-13	13-19	27.5-200	1.8:1
★HP-50	DC-20	20-26	41-200	1.5:1
★HP-100	DC-40	40-55	90-400	1.8:1
★HP-150	DC-70	70-95	133-600	1.8:1
★HP-175	DC-70	70-105	160-800	1.5:1
★HP-200	DC-90	90-116	185-800	1.6:1
★HP-250	DC-100	100-150	225-1200	1.3:1
★HP-300	DC-145	145-170	290-1200	1.7:1
★HP-400	DC-210	210-290	395-1600	1.7:1
★HP-500	DC-280	280-365	500-1600	1.8:1
★HP-600	DC-350	350-440	600-1600	2.0:1
★HP-700	DC-400	400-520	700-1800	1.6:1
★HP-800	DC-445	445-570	780-2000	2.1:1
★HP-900	DC-520	520-660	910-2100	1.8:1
★HP-1000	DC-550	550-720	1000-2200	1.9:1

Price, (1-9 qty), all models: plug-in $14.95, BNC $36.95, SMA $38.95, Type N $39.95

BANDPASS



bandpass, Elliptic Response, 10.7 to 70MHz

Model No.	Center Freq. (MHz)	Passband I.L. 1.5 dB Max. (MHz)	3 dB Bandwidth Typ. (MHz)	Stopbands I.L. > 20dB at MHz	Stopbands I.L. > 35dB at MHz
★BP-10.7	10.7	9.6-11.5	8.9-12.7	7.5 & 15	0.6 & 50-1000
★BP-21.4	21.4	19.2-23.6	17.9-25.3	15.5 & 29	3.0 & 80-1000
★BP-30	30.0	27.0-33.0	25-35	22 & 40	3.2 & 99-1000
★BP-60	60.0	55.0-67.0	49.5-70.5	44 & 79	4.6 & 190-1000
★BP-70	70.0	63.0-77.0	68.0-82.0	51 & 94	6.0 & 193-1000

Price, (1-9 qty), all models: plug-in $18.95,
BNC $40.95, SMA $42.95, Type N $43.95

Constant Impedance, 21.4 to 70MHz

Model No.	Center Freq. MHz	Passband MHz loss < 1dB	Stopband loss > 20dB at MHz	VSWR 1.3:1 Total Band MHz
★IF-21.4	21.4	18-25	1.3 & 150	DC-220
★IF-30	30	25-35	1.9 & 210	DC-330
★IF-40	42	35-49	2.6 & 300	DC-400
★IF-50	50	41-58	3.1 & 350	DC-440
★IF-60	60	50-70	3.8 & 400	DC-500
★IF-70	70	58-82	4.4 & 490	DC-550

Price, (1-9 qty), all models: plug-in $14.95,
BNC $36.95, SMA $38.95, Type N $39.95

NOTE: ★**Add Prefix P, B, N, or S for Pin, BNC, N, or SMA connector requirement.**

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F132 1-2 REVC

not possible for several years with commercial monolithic technology. The companies already have defined a DRAM stack that can be delivered in either 64- or 80-Mbit configurations for use by Lockheed. Contact James Alexiou of Irvine Sensors at (714) 549-8211. *DB*

LITHIUM ION BATTERY EXTENDS LAPTOP LIFE

Development of the first practical bipolar lithium ion battery has been claimed by Yardney Technical Products, Pawcatuck, Conn. With a bipolar lithium ion cell as the power source for a typical laptop computer, operating time between charges would increase from three to four hours to at least six to eight hours. Cellular phones, camcorders, and other portable systems would receive similar benefits. The bipolar design positions a microporous separator between thin positive and negative electrodes in a multicell configuration. This arrangement permits short current paths through the stack rather than across the surface of each electrode. The short paths virtually eliminate resistance losses along or across electrodes, greatly enhancing the rate capability on charge or discharge. It also minimizes self-heating, which frequently limits the life of monopolar cells. While conventional monopolar lithium ion batteries have seen limited use in portables, the bipolar design may accelerate market acceptance of the technology. For more information, call Yardney at (203) 599-1100. *DM*

DEVELOPMENT TOOLS SEEK WINDOWS STAMP

When compared with other areas of development, embedded/real-time design incorporates less concurrent design and fewer tools under one design environment. To fill the void, Software Development Systems, Oak Brook, Ill., has submitted its SingleStep source-level multitasking debugger to Microsoft for Windows verification testing. As a result, developers should be assured of Windows compatibility when developing embedded real-time 68000 applications under Windows. Because the monitor debugger and simulator share the same user interface, a developer can switch easily between simulation and monitor debugging. With SingleStep program building and debugging tools, developers can simulate the target processor directly on the host machine. The toolkit's monitor debugger supplies source- and kernel-level debugging of optimized ANSI C code while programs run remotely in real time. SingleStep works with the Cross Code C compiler package, consisting of a 68000 family ANSI C/C++ compiler, C library, assembler, and linker. For more information, contact Software Development at (708) 368-0400. *SVT*

LEARN ABOUT DEEP SUBMICRON FOR FREE

Deep submicron processing (0.35 to 0.50 μm) brings a whole new set of advantages and challenges to IC designers. Engineers who wish to learn about that topic can attend a free half-day technical seminar being offered around the country by Epic Design Technology, Santa Clara, Calif. The seminar answers questions about managing timing, power, and complexity in deep submicron ICs. Attendees will learn vital information for custom, structured-custom, and high-end ASIC design. The discussions will analyze the ability of existing methodologies and tools to meet deep submicron silicon demands. They will also show an evolutionary hierarchical design methodology for deep submicron design, as well as outline examples of timing and power-management problems and solutions. The 1994 seminar dates include Santa Clara on Feb. 3; Austin, Texas on Feb. 8; Dallas, Texas on Feb. 10; and Boston, Mass., on March 2. Seating is limited. For reservations or more information, call Chris at (408) 988-2997. *LM*

JOINT DEVELOPMENT DEAL YIELDS ATM ICS, CARDS

An chip-development agreement that will focus on simplifying interface design for asynchronous transfer-mode (ATM) systems will ultimately yield a two-chip set, SBus cards, and other host interfaces. Sun Microsystems Computer Corp., Mountain View, Calif., will combine its ability to design ATM segmentation and reassembly (SAR) subsystems with the expertise of Texas Instruments Inc., Dallas, Texas, in integrating complex analog and digital functions. The joint effort will first produce a two-chip set that provides the complete ATM cell transport from the physical layer through the adaption layer. One of the chips, developed by TI, includes all of the physical-layer circuitry. It directly ties in with the other chip, developed by Sun, which performs the SAR functions. Together, the two chips create a low-cost ATM adapter that can transfer data at 155 Mbits/s over fiber-optic and eventually unshielded twisted-pair copper wiring. Future developments will lead to interfaces that operate at 622.9 Mbits/s and higher. Sun also will license its SAR design to TI, which could then offer the chip for commercial use. In addition, TI will have the right to embed the SAR in other products to form a family of ATM-related chips. Contact TI's Steve Perna at (214) 997-5210. *DB*

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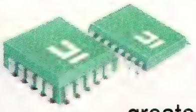

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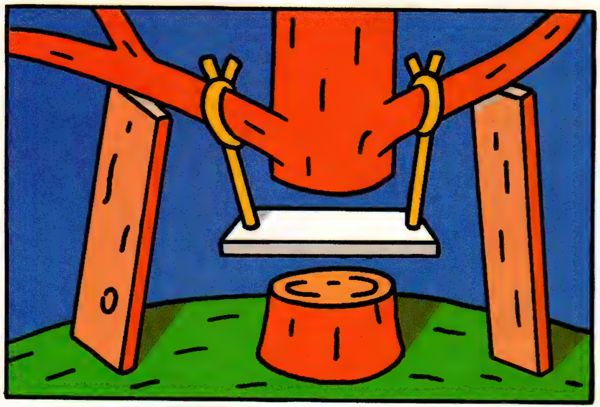
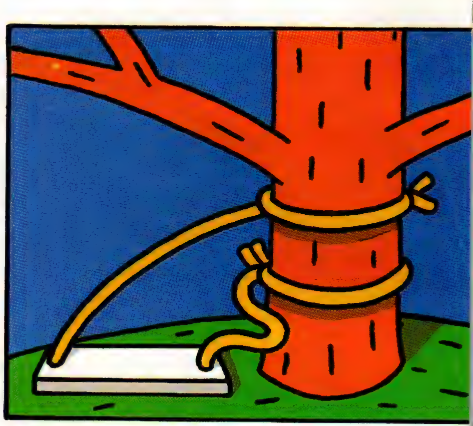
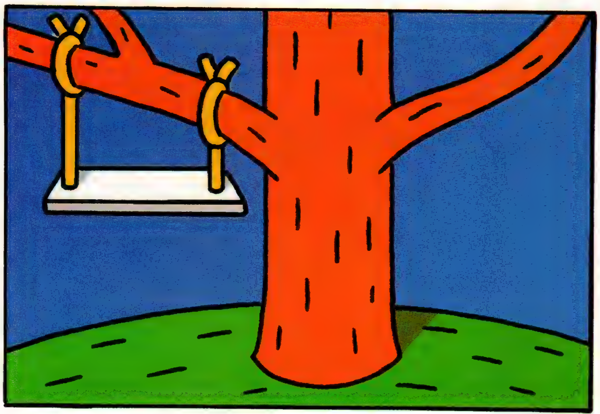
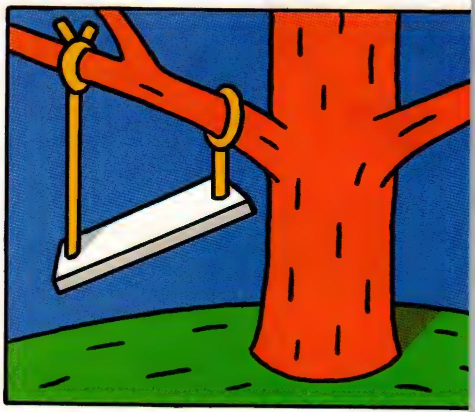
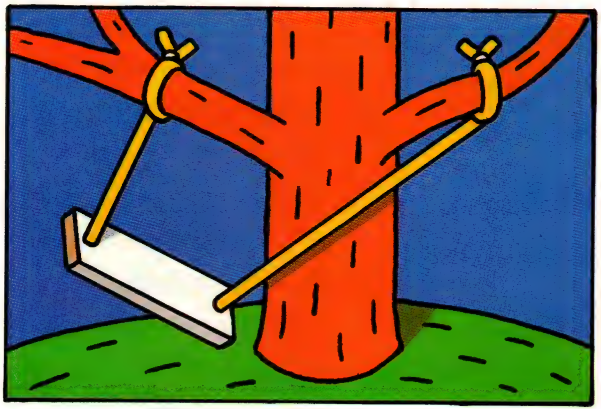
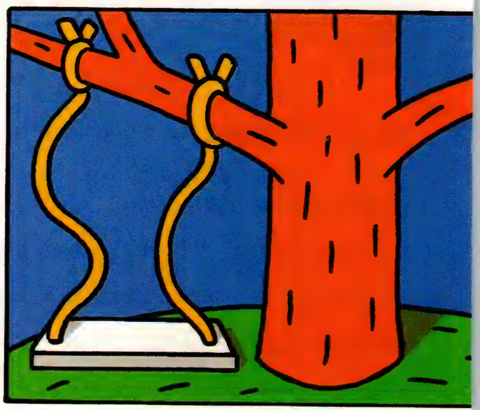

What Marketing Asked For


What Design Specified


How Manufacturing Built It


What QA Approved


What Engineering Developed


What Documentation Described

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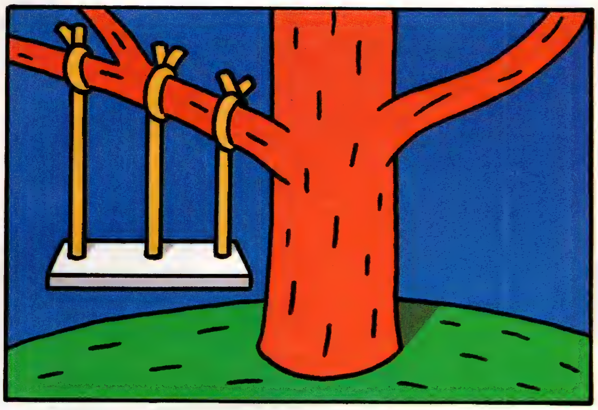
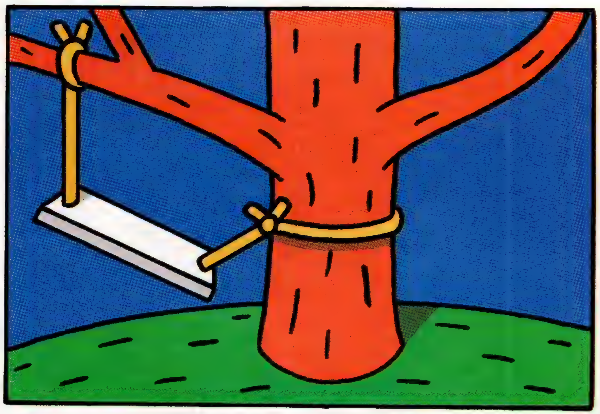
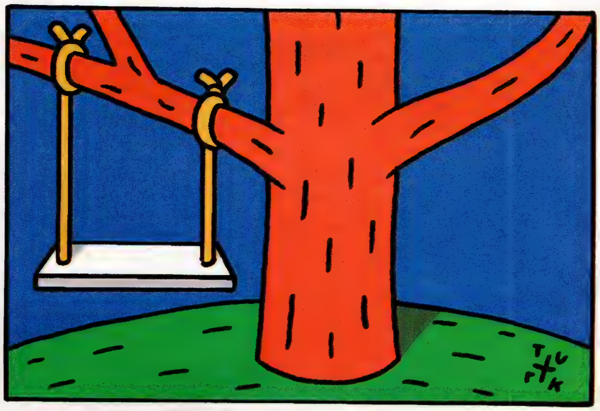


What Management Agreed On



How Marketing Changed It



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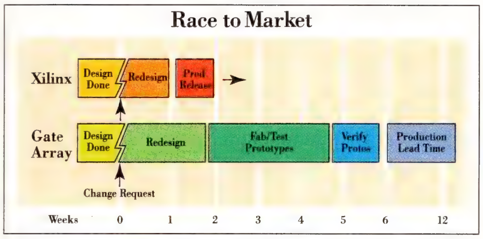

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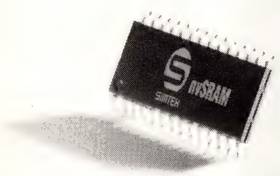
CIRCLE 174 FOR U.S. RESPONSE

CIRCLE 175 FOR RESPONSE OUTSIDE THE U.S.



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CIRCLE 154 FOR U.S. RESPONSE CIRCLE 155 FOR RESPONSE OUTSIDE THE U.S.

SUPER-THIN OXIDE LAYER YIELDS QUANTUM DEVICES ON AMORPHOUS SILICON DIOXIDE

By keeping the strain layer in a silicon-based superlattice structure extremely thin (a few monolayers thick), epitaxial silicon was able to be grown on amorphous silicon dioxide. With this development, researchers at NanoDynamics Inc., New York, N.Y., created silicon-based quantum transistors—one of the first silicon-based quantum structures to operate at room temperature. The silicon dioxide acts as a barrier for a quantum well. The barrier layer, of course, is key to quantum structures—no barrier, no device.

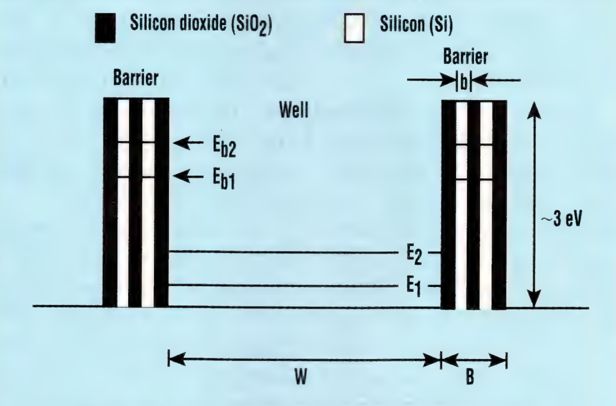


Figure 1 Silicon-based strain-layer superlattice (SLS) barrier with quantum well

The "availability" of quantum barriers in silicon structures opens up many device possibilities to silicon-based circuits that were previously only possible with III-V compounds, such as gallium arsenide (GaAs), gallium aluminum arsenide (GaAlAs), gallium indium arsenide (GaInAs), aluminum indium arsenide (AlInAs), and others. As a result, optoelectronic devices and other nonlinear optical elements might eventually be formed in silicon. Furthermore, the silicon-based strain-layer superlattice (SLS) combines the ease of silicon manufacturing technology with the multifunctionality and higher mobility representative of III-V compounds.

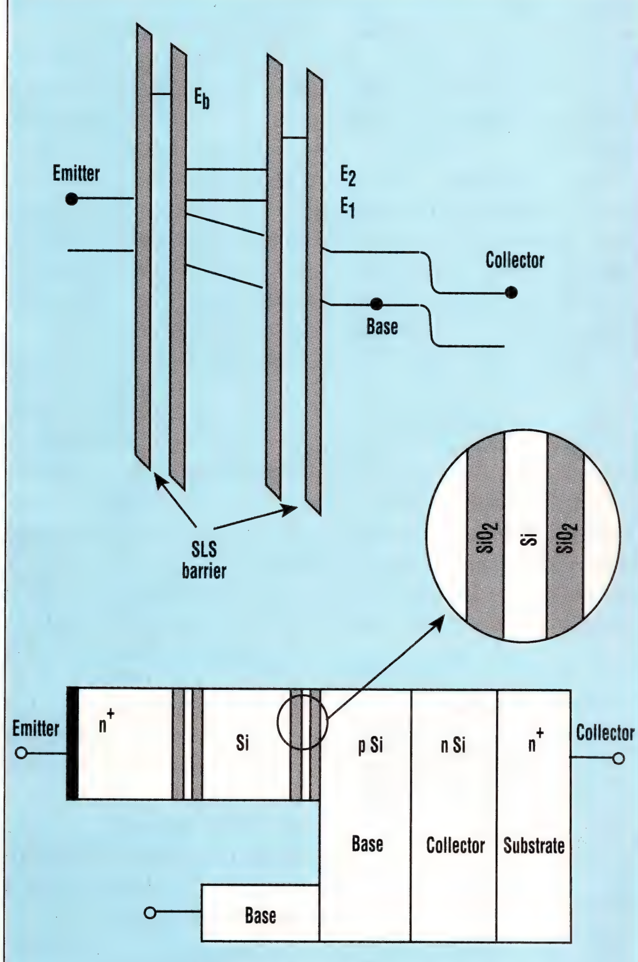


Figure 2 SLS-barrier transistor, where emitter bias controls current flow from base to collector or vice versa, and energy-band diagram at the top

To make the structures, researchers at NanoDynamics start with a specially-designed molecular-beam-epitaxy (MBE) deposition system that employs a high-vacuum environment. The MBE system uses a set of pivoting nozzles that deposit the gaseous molecules on a heated and rotating substrate. The substrate's speed of rotation and the beam-slit opening control the rate of deposition to the level of a single atomic layer. The narrow molecular beams aim straight to the exhaust except when the beam is pivoted for deposition. By avoiding beam scattering, the MBE chamber's design allows the high level of vacuum to be maintained in the chamber, and thus the high level of control.

Previous research work in III-V materials and silicon has been based on the use of a resonant-tunneling diode as the emitter or base of a transistor. With careful design, researchers were able to form energy separations that are much greater than the thermal energy at room temperature (if the energy separations have values less than the thermal energy, the energy states overlap and effectively smear the quantum states, making the structure unusable). In the SLS-barrier approach, the quantized energy levels E_n are above the thermal level and are boxed in by the SLS barriers, which have an effective barrier height of E_b *(Fig. 1)*.

Starting with the same structures as those employed in resonant-tunneling GaAs-based bipolar transistors fabricated between six and seven years ago, the GaAs quantum-well structure is replaced by silicon-dioxide/silicon/silicon-dioxide SLS barriers. With proper design, the barrier height of an energy-level E_b can be made almost as high as the barrier height of silicon dioxide and silicon (3.2 eV in the conduction band). Thus, energy separations, E_2-E_1, E_3-E_2, etc., can be designed to be much greater than the thermal energy at room temperature *(Fig. 2)*.

SLS barriers also can be applied in FET structures where the channel between the source and drain is replaced by a quantum well. A thicker SLS barrier restricts the resonant-tunneling current as much as possible. When a constant electric field, V, is applied to a periodic system, the energy state is quantized to form Stark Ladders with separation aVa, where a is the period of the periodic potential of the solid. Then, when a voltage is applied to the gate (V_g), the quantum state of the well (E_1) is made to align with the Fermi level. This permits electrons to enter (occupy) the E_1 state. Then, when a voltage is placed across the source and drain, current flows as electrons hop from state to state through a series of Stark Ladders. In the Stark Ladder, each time a given quantum state is occupied, a current can flow between the source and drain, giving the device multiple on states—one for each bias level.

Because certain multiple voltage levels will cause the same current to flow, the transistor structure can form the heart of multifunctional logic systems. The ability to respond to different voltage inputs and trigger a consistent response could, for example, serve as the basis for a highly efficient implementation of multilevel logic circuits. Such multilevel implementations can drastically reduce the amount of circuitry needed to build complex functions. In addition, the approach can be used for some other type of weighting scheme in various control systems.

An alternative to the basic polysilicon-gate FET is to use an aluminum gate. With such a change, the large Fermi sphere of the aluminum results in a stepwise occupation of the quantum states. Furthermore, the aluminum gate greatly increases the effective mobility in a two-dimensional quantized electron-gas system (a quantum well represents a 2D system). Consequently, a 2D FET isn't only multilevel functional, but can also be faster than a traditional 3D FET with the same operating parameters.

For licensing information, contact Adrian Horne at (203)357-1696.

DAVE BURSKY

DIGITAL COMPENSATION INCREASES THE LINEARITY OF THIN-FILM POTENTIOMETERS TO OVER 12 BITS

Precision potentiometers, or "pots," have been used as feedback sensors for over 50 years. Along with op amps, they've been at the heart of analog fire-control computers that got us through both World War II and the Korean War.

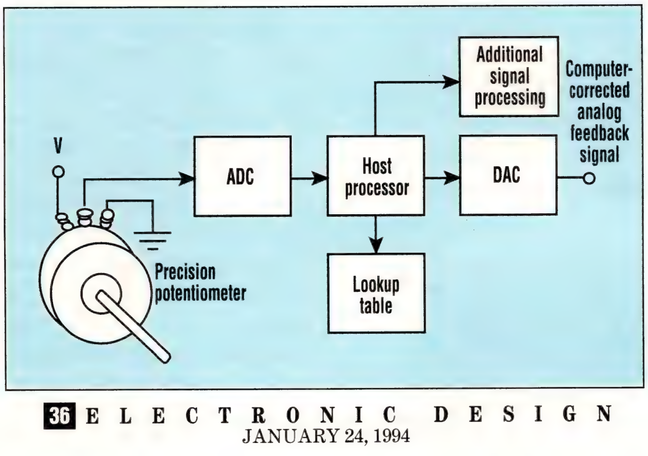
Those early devices were of the wire-wound variety and provided users with limited resolution. Today, thick- and thin-film pots with infinite resolution are available as cost-effective alternatives to optical encoders and resolvers or synchros. But their "as manufactured" nonlinearity error can run between 1% and 10%. Such nonlinearity errors may be sufficient for some applications but is totally unacceptable for others. Mechanically trimming thin-film pots, however, can reduce nonlinearity errors to under 0.2%.

Vernitron, Herndon, Va., a supplier of precision thin-film pots, has taken this mechanical-trimming method one step further. It came up with a digital calibration scheme that brings a pot's nonlinearity error to within less than a single least-significant bit (LSB) out of 12 bits.

The pot is calibrated by mounting it in a master jig. The device's wiper is indexed through a number of precisely preset angular or linear increments along its resistive element (for example, every 0.5°). The pot's output (the voltage on the wiper) is digitized, and the difference (error) between it and the digital value of the known "correct" voltage is calculated by a system processor and stored in memory.

To calculate correction factors, the electrical travel of the pot is essentially divided into equal segments whose number is determined by the pot's output-voltage range. While only 16 to 32 segments are used for the complete device, a "cluster" of multiple data points are taken over each segment.

Each segment represents a portion of the pot that produces a unique transfer value. That value can be used to create a "best-straight-line fit" through the mean value of the cluster of data points for that segment. Using regression analysis produces a slope and intercept point for each straight-line segment. It's a simplified technique for calculating a continuous set of output values for any output falling within that segment. The end user of the digitally-calibrated pot is provided with a set of 16 (or 32) slopes and intercepts on a floppy disk for each pot, or in some other form of nonvolatile memory like RAM, ROM, or EEPROM.


Additional signal processing
Computer-corrected analog feedback signal
V
ADC
Host processor
DAC
Precision potentiometer
Lookup table

In addition to the pot, the final system needs both an analog-to-digital converter (ADC) and a digital-to-analog converter (DAC) circuit (*see the figure*). Depending on the circuit employing the pot, additional computational capability may also be needed.

In this circuit, the pot's output is applied to the ADC, which in turn feeds its output to the host processor. The processor can access the pot's slope and intercept data in the lookup table.

As the digital word from the ADC changes, the host repeatedly accesses the lookup table. Along with the slope and intercept for each segment, a correction value is calculated for each new output voltage from the pot's wiper arm. The corrected value is then applied to a DAC to create a feedback voltage.

For additional information, call Dennis Akers at (703) 478-9800.

FRANK GOODENOUGH

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• CIRCLE 305 FOR IBM • CIRCLE 306 FOR SPARCSTATION

POST-PROCESSING SCHEME ELIMINATES COMMERCIALS FROM RECORDINGS

A post-processing algorithm has made it possible to automatically eliminate commercials from any television program recorded on a videocassette recorder equipped with the technology. The patented scheme, called Commercial-Free, hinges on the algorithm's ability to recognize the difference between program breaks that denote commercial messages and those which are dramatic devices within a program.

The problems with approaches at commercial elimination in the past was that they attempted to detect broadcasted commercials in real time. However, no technology to date has been able to instantaneously distinguish between events that are happening during a broadcast relative to the beginning and end of commercials. Consequently, nothing on the market has delivered this benefit.

Jerry Iggulden, who invented Commercial-Free for Arthur D. Little Enterprises, Cambridge, Mass., decided to take a different approach. His new system is able to eliminate commercials in playback through the use of post processing. The technology scheme allows a VCR to record a program on a videotape in the typical way while simultaneously mapping the program in electronic memory through the use of an 8-bit microprocessor (a variety of microprocessors can be used to do the job).

The key to the commercial eradication process is the system's ability to recognize the beginnings and endings of commercials, which are characterized by black frames and low-sound events. While recording a broadcasted program, the system "marks" these black-frame and low-sound occurrences and stores them in memory (a nonvolatile VRAM) along with the time that they occur on the tape. At the end of a broadcast, there is then a record (like a histogram) where these features are marked over, say, a 60-min. period.

By analyzing the pattern of those records, several interesting patterns were discovered. Iggulden noted that black frames and low-sound events occur for one of two reasons. In some cases, they designate a dramatic scene change, which are seen on the "map" as single black-frame events.

The second occurrence of black frames are commercials. Here, the black frames occur in clusters, which represent the breaks between the program and the opening commercial of a commercial group, the successive commercials that are joined shoulder-to-shoulder in any commercial television presentation, and the last black frame, which marks the line between the commercial group and the start of the program again.

"We found this to be enormously consistent, to the extent that it's virtually a rule," Iggulden explains. "Typically, there are seven or more of these black-frame clusters gathered within a small period of time. What we were able to do with that information, in retrospect, was use a microprocessor to pick out (through an algorithm) the beginning black frame, which marks the start of a commercial, and the end black frame, which marks the end of a commercial group. The algorithm can distinguish between those black-frame occurrences and those that signal dramatic scene changes."

Iggulden notes that thousands of hours of development went into the algorithm. The result was a series of rule sets that allowed the technology to deal with virtually any type of broadcast situation, from sitcoms to movies.

By virtue of a clock, the system detects where the top and bottom of a broadcast occurs. Consequently, it "knows" when it's seeing a teaser, a trailer, etc. Of course, the power of the post-processing technique hinges on the assumption that an extensive rule set—one which covers all possible broadcast situations—can indeed be defined.

The only downside, therefore, is the human factor. There are bound to be some instances when the program is missed or a commercial is left in (if, for instance, a broadcaster miscues. But there's no real harm done: The entire broadcast is still on the tape.

"One of the best features of the system is the perfect interface: No interface," says Iggulden. "There is virtually no intervention from the users, except what they typically do, which is plug in a videotape, program their VCR the way they normally do, and play back the tapes at their convenience."

The Commercial Free technology will initially be implemented in two separate products, The first product is a standalone attachment to a VCR called Commercial Brake, which will be introduced by Arista Technologies Inc. of Long Island, N.Y., this year. As early as January, 1995, Arthur D. Little Enterprises expects to see the Commercial Free technology integrated into VCRs. The feature is expected to add between $40 and $60 to the cost of a VCR.

For more information, contact Jerry Iggulden at 1-800-677-3000, ext. 5260.

CLIFFORD METH

Portable by Design

See Page 145 for more details

"If you doubt the power of advertising I suggest you consult a doctor."

"Colon cancer is a disease that afflicts more than 150,000 Americans each year and eventually kills over half. Yet, any doctor will tell you that with early detection, the survival rate could be raised to as much as 90%.

Can advertising have the power to make people confront this disease, overcome their fear and actually consult their doctors about it?

You bet your life it can.

Take the case of the Advertising Council's campaign against colon cancer. The first-ever study of public service advertising that actually isolated the impact of advertising from other market elements like the news, editorials and public relations.

Research was conducted from July 1989 to July 1990 in 4 markets in 10,000 households, at the equivalent of $21.3 million worth of air time, the average amount of donated time behind Advertising Council spots.

After six months of being exposed to one commercial, awareness of colon cancer among adults 40 and over rose from 11% to 29%.

After a year, awareness reached 40%.

The number of men who consulted their doctors more than doubled to 15%.

Now, if advertising can get people to see their doctors about something as unpalatable as colon cancer, don't you think it can get people to consider your product?

Don't find out colon cancer is curable too late in life.

Herb Baum, Pres., Campbell North & South America and Chm. of the Advertising Council.

Oh, there's one more thing. If you're over 40, ask your doctor about colon cancer."

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City trees add the soft touch of nature to our busy lives. They cool our cities, fight pollution, conserve energy, give wildlife a home, and make our neighborhoods more liveable.

The trees on city property, along streets and in parks, are an essential part of the urban forest. To keep these trees healthy and abundant, your town needs an organized program for their care…an annual action plan to plant and prune the city's trees, and to maintain their health.

You can make a difference — by planting and caring for trees in your yard and in your neighborhood, and by encouraging your city government's community forestry program.

Support Tree City USA where you live. For your free booklet, write: Tree City USA, The National Arbor Day Foundation, Nebraska City, NE 68410.

The National Arbor Day Foundation

"Without advertising, everybody would think Ronald was just the name of a former president."

Mike Quinlan, Chairman, CEO McDonald's (left)

"The remarkable thing is, when you think about McDonald's® you've got to think about people. A friendly crew person welcoming you. Kids, moms and dads having a good time at McDonald's, even a funny clown named Ronald.® Those pictures in your mind are advertising at work.

Our advertising is people to people—an invitation from our people to our customers to come in and visit. Personal, friendly, and above all, real.

I'm told there are business people out there who don't believe in the power of advertising. For them, two facts: First, McDonald's is one of the most advertised brands on this planet. Second, McDonald's is the only company listed in the current Standard and Poor's 500 to report combined increases in revenues, income, and earnings per share for more than 100 consecutive quarters since 1965.

Frankly, Ronald and I like to think there's a connection here."

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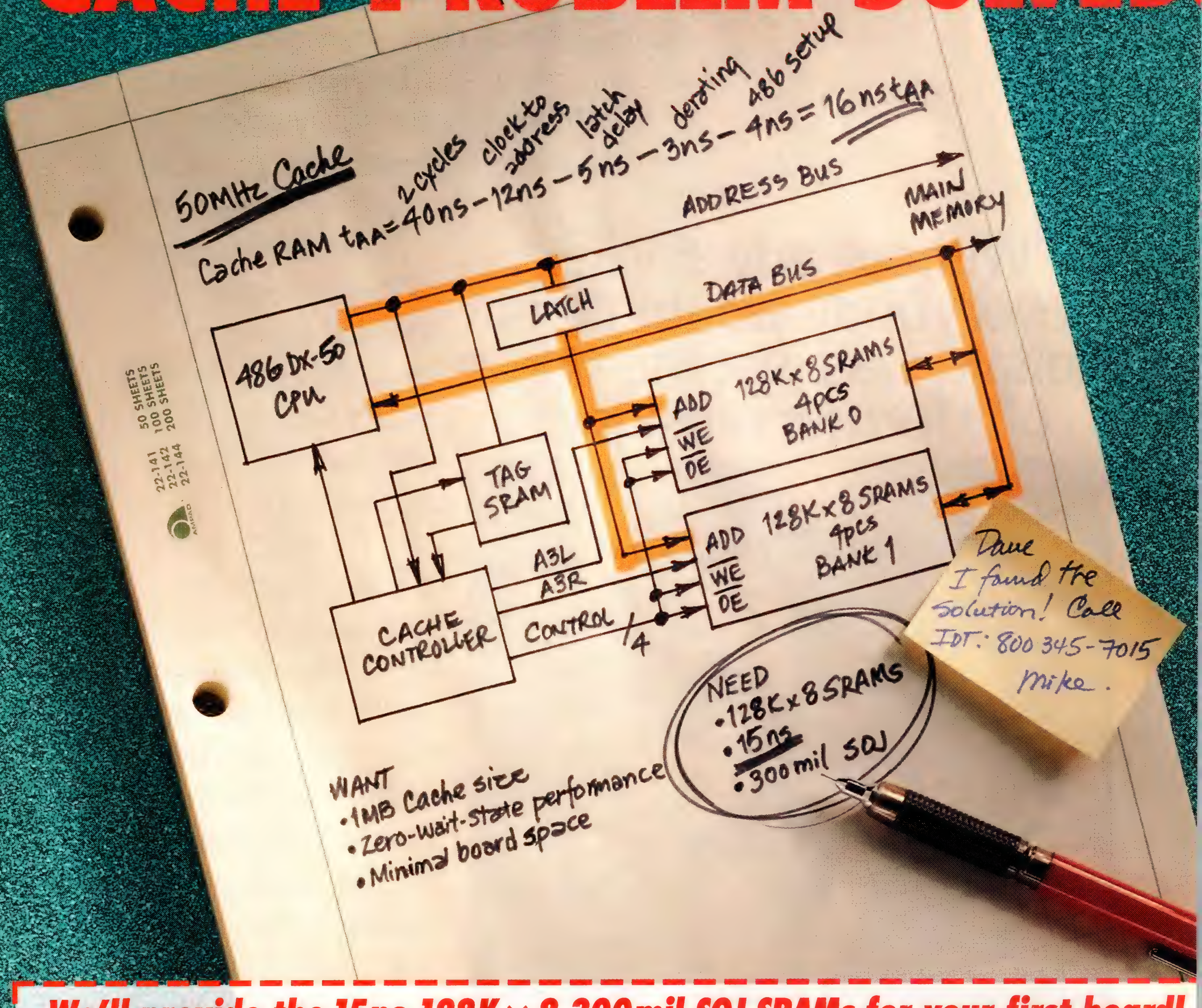

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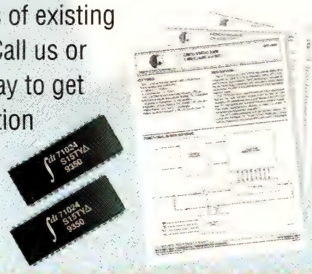

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Integrated Device Technology, Inc.

LASERS LIGHT THE WAY FOR MO DRIVES

IMPROVED HEADS AND RECORDING FORMATS WILL EXTEND PERFORMANCE AND CAPACITY.

RICHARD NASS

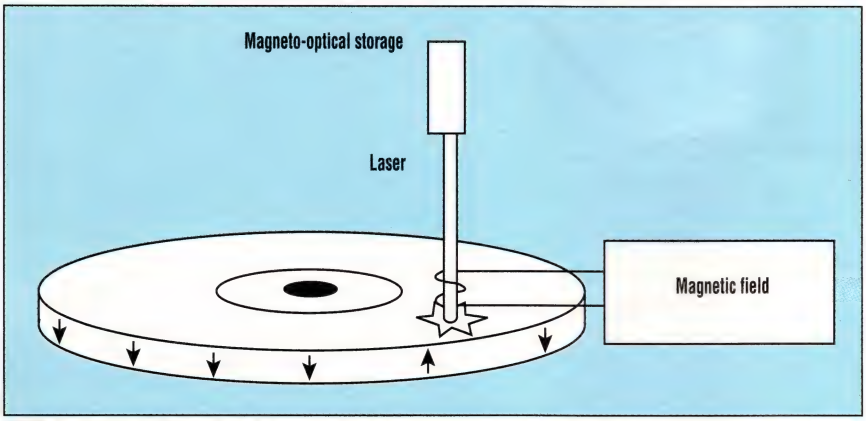
With increasing performance levels and rising storage capacities, the outlook for magneto-optical (MO) disk drives is brightening. MO disk drives have been touted as a replacement to traditional hard-disk drives for some time, with the one important advantage of removability. Despite the fact that they're still too slow and cost too much, their performance and storage-capacity levels continue to rise. The performance boost is mainly due to two changes in architecture: a direct-overwrite capability, and the use of pulse-width modulation (PWM) as a recording format. Other future enhancements are expected due to improvements in lasers.

The recording process in a magneto-optical drive relies on the recording material's fixed temperature point—the point at which magnetization is lost. This is called the Curie Point (named after Pierre Curie, the French chemist who made this discovery in the late 19th century). In MO disk drives, a laser heats the media to the Curie Point of around 300°F, allowing the media's polarity (a zero or a one) to be changed with a relatively small magnetic field.

To record a sector of data in a MO drive, that sector would be heated with the laser. The magnetic field then directs all of the bits in one direction, making them all zeros—analogous to creating a blank page. Then, a second pass is made by the laser. But this time, the polarity of the magnet is reversed. In this pass, the laser only heats the bits that are to be changed. Then, as the magnet passes, only those bits are changed *(Fig. 1)*. A third pass is made to verify the accuracy of the written data.

This three-pass technique actually is one of the limiting factors of MO drives. Because the drive's latency is about 24 ms (the time it takes the disk to complete one revolution), that's the theoretical minimum time required to clear the disk and write the data. In practice, the average access times of today's MO drives are just starting to break 50 ms. Comparatively, mainstream Winchester hard-disk drives offer an average access time ranging from 10 to 15 ms.

Designers of magneto-optical drives say it's not fair to compare their drives with Winchester drives. Says Werner Glinka, director of product marketing at Maxoptics Corp., San



1. THE FIRST PASS of the laser-magnet combination in a magneto-optical disk drive clears the sector of any data. The second pass writes the data to the "blank" disk by reversing the magnetic field.

Jose, Calif., "The biggest reason that MO technology lags behind magnetic technology is because it became mature almost a decade later. And what you see today in the magnetic arena has a huge cost advantage because of the volumes in use. Optical devices will eventually reach that point."

TWO HEADS ARE BETTER

One attempt to reduce the drive's latency was to position a second head 180° from the first head. Here, the two heads' magnetic fields would have opposite polarities. This was difficult to maintain, because the two heads had to be insulated from one another to avoid interference. This type of dual-head mechanism was actually developed in Japan, but it failed to reach the market because of its high cost.

Going one step further, IBM's Almaden Research Center, San Jose, Calif., is developing a three-head laser. The three cycles that the system typically runs through would be reduced to just one. Currently, the system erases, writes, and verifies the data, with each procedure requiring one revolution of the disk. With a three-element laser, the first beam would erase, the second would write, and the third would do the verification, all in one pass. This scheme, called direct-read verification, was demonstrated in the laboratory. But, it has yet to appear in a product simply because it's too expensive.

Maxoptics tries to skirt the three-revolution problem by implementing a comprehensive write-caching scheme. By looking at how the host typically writes data to the drive, some of the drive overhead can be reduced or eliminated. With a fairly large write cache, say 4 Mbytes, data can be written to the cache initially and then transferred when it's more convenient (as long as the data doesn't exceed the size of the cache). The caching algorithms used on magnetic hard disks could be implemented on optical drives as well.

One drive that makes the most out of its cache memory is the LaserSafe Plus, developed by Iomega Corp., Roy, Utah. The 1.3-Gbyte drive, which fits a 5.25-in. form factor, employs a 4-Mbyte cache memory and spins at 4800 rpm to lower its average seek time to just 19 ms. The latency time ranges from 6.25 to 8.9 ms. The drive also boasts sustained read and write rates of 2.2 and 1.1 Mbytes/s, respectively.

Many optical-drive manufacturers are still trying to develop single-pass (direct-overwrite) systems, where the biggest performance gains will be realized. For instance, phase-

THE LATEST IN LASER TECHNOLOGY

The lasers employed in a majority of desktop magneto-optical drives typically consist of gallium aluminum arsenide (GaAlAs) and feature a wavelength of 780 nm. Generally driven by about 2 V, such lasers require currents ranging from about 50 to 100 mA, depending on whether the device is reading or writing.

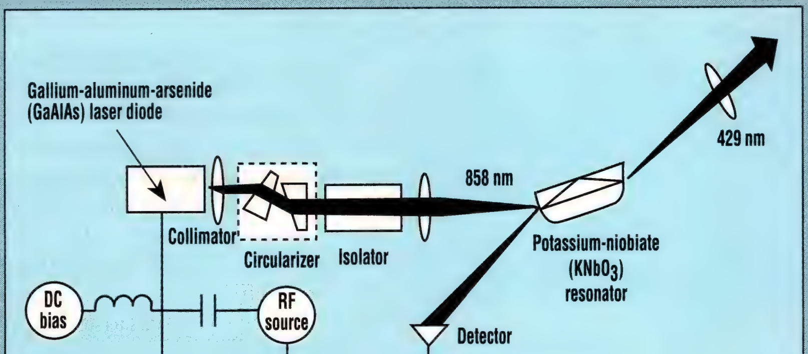
Shorter-wavelength lasers are on the horizon. For example, red lasers, with a wavelength of 680 nm, should appear in magneto-optical drives later this year. They will eventually be followed by blue lasers, which have wavelengths between 410 and 470 nm. Though blue lasers currently can't be manufactured at a price that users would be willing to pay, much research is going into producing cost-effective blue lasers.

IBM is one of many companies at the forefront of laser research. Says Bill Lenth, manager of optical storage technology at IBM's Almaden Research Center, "We have a blue laser that's about the size of a complete 3.5-in. magneto-optical drive. The laser can be made smaller, but it clearly won't be the size of a semiconductor chip for awhile."

The device has an infrared semiconductor laser, with a wavelength of 858 nm, at its front end. The IR light is converted into blue light (429 nm) using a process called frequency doubling *(see the figure).*

"That laser has all the performance attributes needed for optical storage," says Lenth. "We've used it for magneto-optical recording at an areal density of 2.5 Gbits/in.^{2}, which is the highest right now for magneto-optical recording." This translates into a capacity of 6.5 Gbytes on a 5.25-in. disk. Blue-laser technology will probably start out in high-end storage products, such as optical jukeboxes that house numerous disks.

IBM already has licensed its blue laser to a company in the biomedical industry. Other applications include printing and silicon-wafer inspection tools.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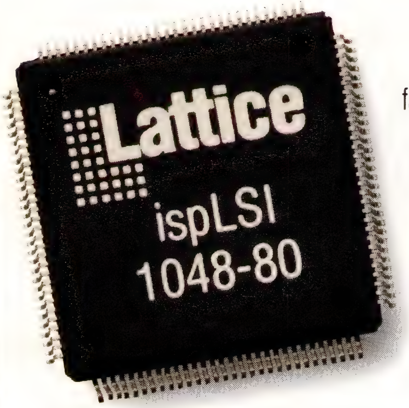

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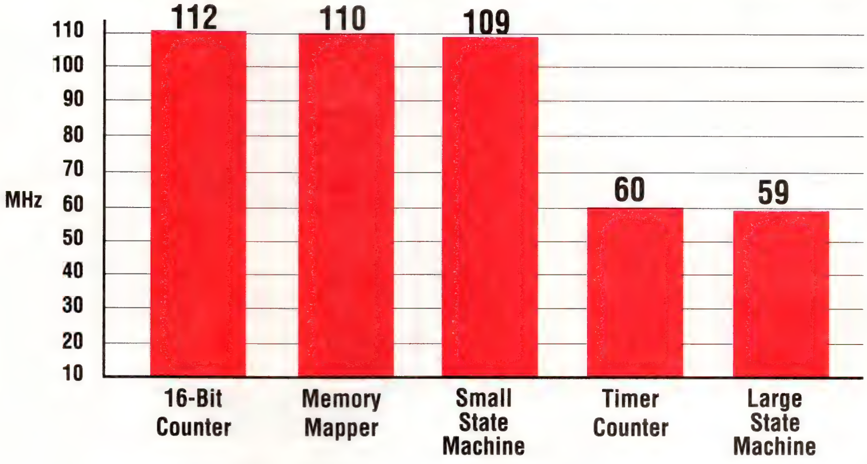

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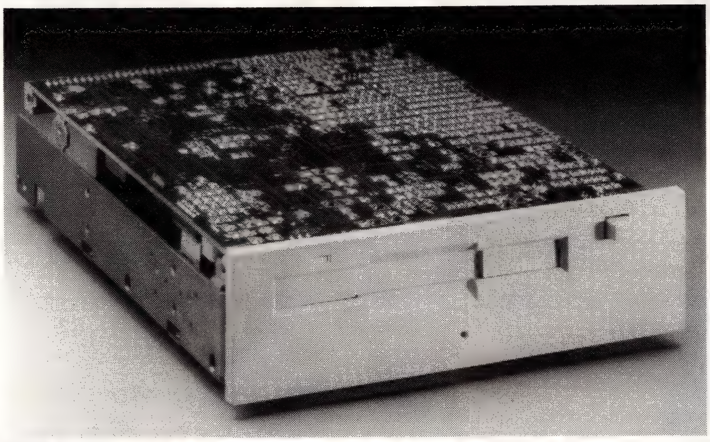


2. THIS MAGNETO-OPTICAL disk drive, the RMD-5300-S designed by Mass Optical Storage Technologies, has a capacity of 384 Mbytes. This is achieved by employing a soft-sectored format where the sector headers are written during the format operation, causing a tighter track width.

change technology is one way to handle direct overwriting. With the phase-change technique, different temperatures are used to create ones and zeros by altering the crystallized nature of the substrate. For example, heating the media to X° causes the bit to change to a zero. Heating it to X+100° makes a one. The problem with this technique is that there's a finite number of overwrite (erase) cycles—around 100,000 with current technology. But, as of now, that number is acceptable, and it should grow as the technology evolves.

The direct-overwrite architecture suits 3.5-in. drives, putting them into competition with Winchester drives. Lee Payne, product marketing manager for MOST (Mass Optical Storage Technologies) Inc., Cypress, Calif., says "For direct overwrite to become mainstream, it would have to be economically feasible. We've been working with the technology for a few years now. It would add about $40 to $50 to the cost of the drive. But it definitely increases the write performance almost to the level of the Winchesters."

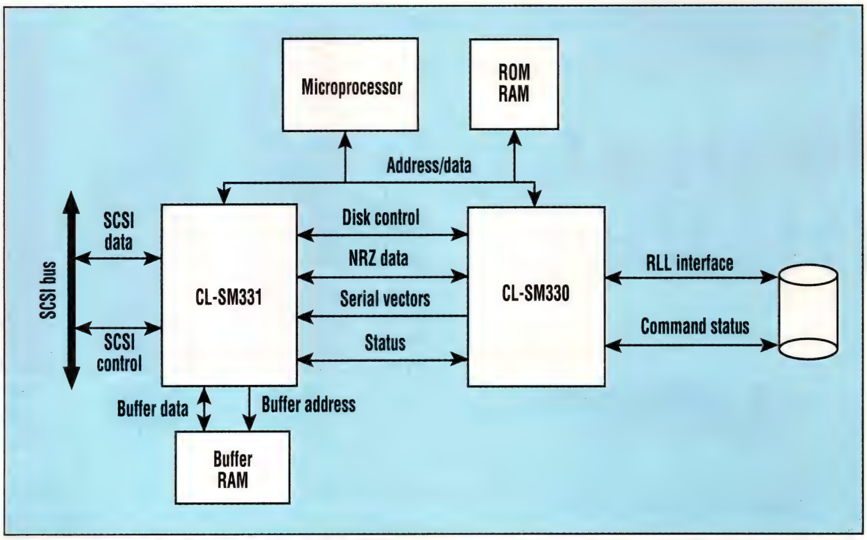
TWO BITS PER DOT

The way in which the data is actually laid onto the media can impact the density of the bits, in turn affecting the disk's overall capacity. Most of today's disk drives employ a recording scheme called pulse-position modulation (PPM). A look through a microscope at a PPM disk would show small dots with a varying distance between them. The one or zero would lie at the center of the dot. A recording format that's new to MO drives is PWM, which aims to increase the bit density. With PWM, there's two bits for each dot, one on each edge of the dot. Theoretically, this doubles the recording density. In practice, though, it offers an increase of about 40 to 50%. MOST is one of the few drive manufacturers currently shipping PWM-based optical drives.

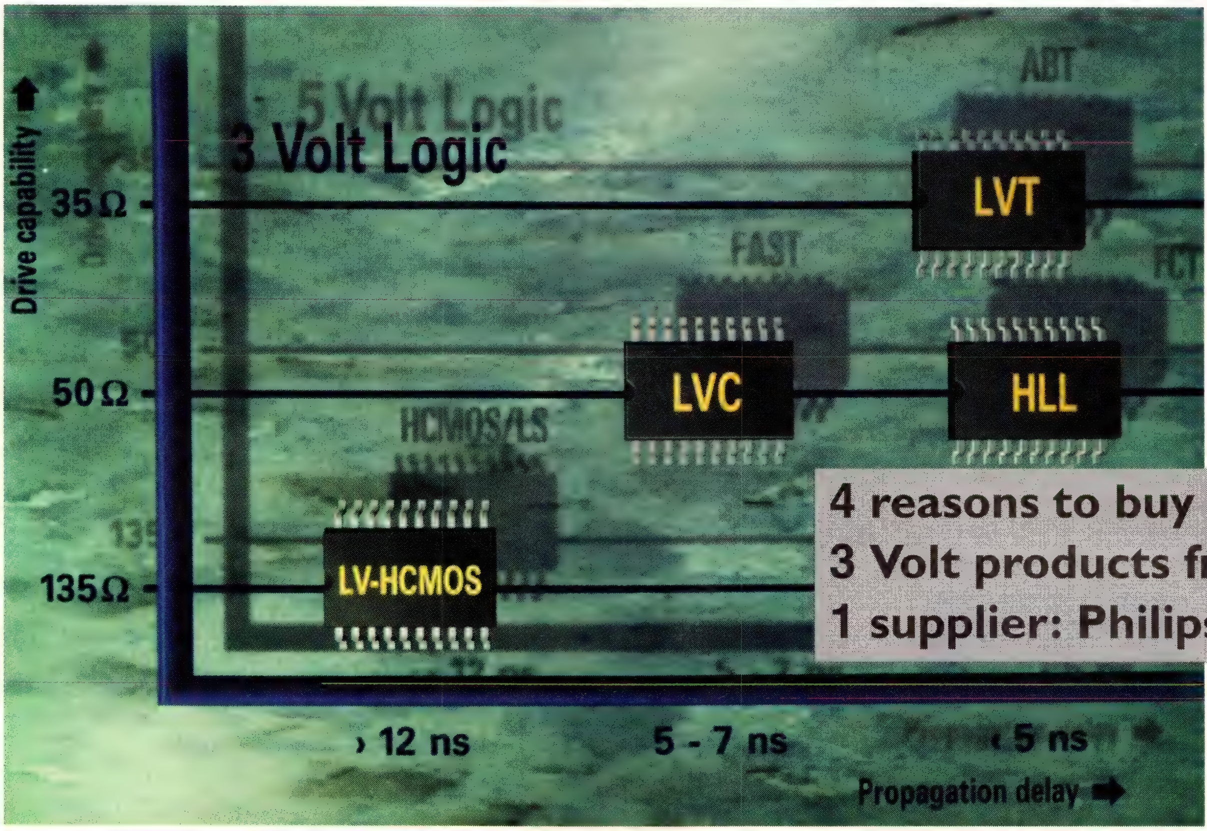
A main driving factor for recording technology is the availability of lasers. The laser's wavelength determines the dot size on the media, and therefore the bit and track densities *(see "The latest in laser technology," p. 44)*. Most MO-drive lasers in use today have a 780-nm wavelength (the 780-nm laser was developed in 1991). At that time, the laser cost about $250; now it's about $18. Work on a 680-nm (red) laser is almost complete, and is expected to come on the market sometime this year. The shorter-wavelength laser will reduce the distance from track to track because of the smaller spot of light it produces, ultimately resulting in higher track and bit densities. The track density of the media is currently 17,000 tracks/in. and the bit density is close to 25,000 bits/in.[2]

The media in a MO drive consists of two layers of sensitive material that are sputtered onto a glass or polycarbonate substrate. That sandwiches the recording layer, protecting it between two substrates. The laser beam hits the outer layer of the glass substrate and reads through its surface. This differs from traditional Winchester drive media, which is typically made of aluminum, although some smaller form-factor drives use a glass disk. While the Winchester recording surface is always the outside layer, the layer on the MO disk is sandwiched between two glass substrates. The media type can't be readily changed without making other changes to the drive. In addition, both sides of the disk can be written to.

Recording heads for MO drives differ widely from those of Winchester disk drives: The Winchester heads are tiny with extremely low mass, while the recording head or optical pickup unit (OPU) for a MO drive is large and clumsy, weighing



3. TO FORM A COMPLETE optical-disk-controller subsystem that can connect to a SCSI bus, the Cirrus Logic CL-SM330/331 two-chip controller set must be surrounded by buffer memory, a data separator, and a local microcontroller with system RAM and ROM.



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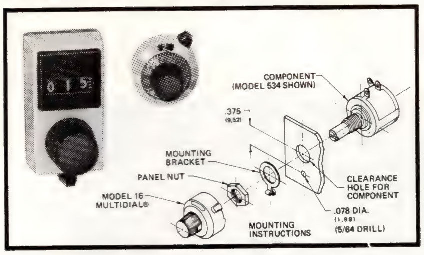
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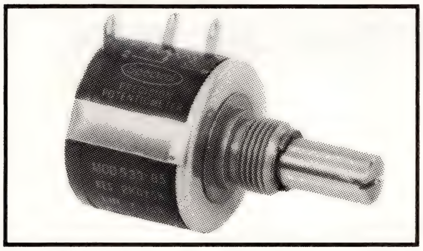

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about 18 g.

The OPU doesn't fly over the disk like a Winchester head. Instead, it's lowered onto the disk, about 1 mm from the disk surface. A servo system measures the distance between the head and the disk surface to make sure that the laser beam stays focused on the disk. Some recent developments have quickened the head movements by removing some of its mass, resulting in a lower access time.

SOFT-SECTORED FORMAT

A magneto-optical disk's capacity also can be increased by improving the disk-format method. Using the standard 256-Mbyte media, MOST developed a soft-sectored format that increased the capacity to 384 Mbytes. This technique was already used in the company's RMD-5300-S drive *(Fig. 2)*. Although the unit holds 384 Mbytes on a disk, it's backward-compatible with the previous-generation 128- and 256-Mbyte drives. With the soft-sectored format, the actual sector headers are written during the format operation. Traditionally, the disks employ an embossed format, where the physical sector information is stamped onto the media. By writing the sector information during the format process, a more flexible format structure can be created on the media, resulting in a tighter track width and ultimately a higher storage capacity per disk.

Performance can be improved by increasing the disk's spin rate. Maxoptics employs a high-bandwidth servo system that spins the disk at 4800 rpm, about the fastest that's currently available in MO drives. The problem with the faster spin rate is that the electronics within the drive have trouble keeping pace.

"We could spin the disk at 3600 rpm without much of a problem," says MOST's Payne. "But the inner-sector times would be so narrow that if error correction was needed to recover a sector, the drive would blow by the next sector completely. Then you have to wait for the disk to come back around. So what you must do is weigh spindle speed against error correction to get the best balance of performance."

For example, MOST spins the disk at 2400 rpm and gets a data rate ranging from about 600 kbytes/s to about 1.2 Mbytes/s. If the spin rate were increased to 3000 or 3600 rpm, the drive's true data-rate capability would probably diminish because of the electronics. The raw error rate, which is about 1 error in 10^5 bits, improves to about 1 in 10^{12} using error correction. But, for example, when correction must be applied to sector one, the head has already passed sector two. Now, the error-correcting electronics must wait one rotation for the data to come back under the head. If that happens often enough, the data rate would be drastically reduced.

A LACK OF SILICON

Because of its slow market acceptance, most semiconductor IC companies have been reluctant to design and mass-market devices for MO disk drives. Explains Nicos Syrimis, director of marketing at Cirrus Logic, Fremont, Calif., "The only question is whether there's a sufficient marketplace for us to develop controllers for the new standards. So far, the market growth has been significantly lower than what was anticipated. We must weigh whether or not it makes business sense to do it."

Cirrus Logic's existing controller set, the two-chip CL-SM330/331, was designed to handle a 24-Mbit/s non-return-to-zero (NRZ) data format. The SM330/331 requires buffer memory, a data separator, and a local microcontroller with system RAM and ROM to form a complete optical-disk-controller subsystem. This subsystem would then connect to a SCSI bus *(Fig. 3)*.

Zone-bit recording, a technique embraced by hard-disk makers over the last few years, is starting to find its way into MO drives. This means that the zones on the disk remain the same size regardless of whether they're near the disk's inner or outer edge. This allows more zones to fit on the disk.☐

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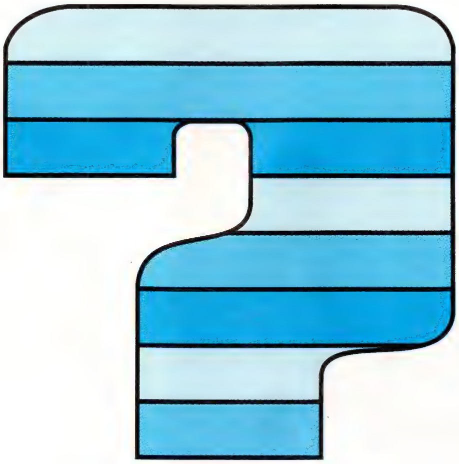

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TVP3020

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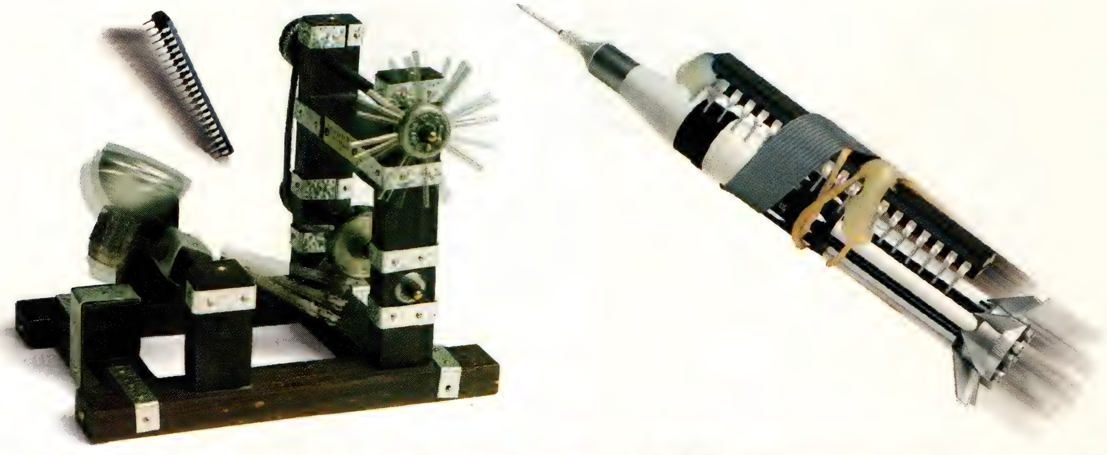

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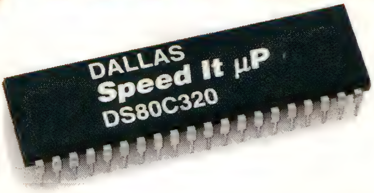

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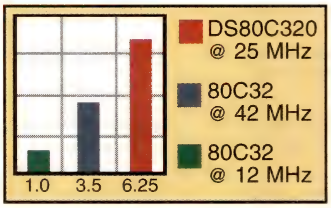

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ENGINEERING SOLUTIONS FOR A NOMADIC WORLD

THE PORTABLE BY DESIGN CONFERENCE BREAKS NEW GROUND BY CONSIDERING THE TOTAL SYSTEM SOLUTION.

DAVE MALINIAK, RICHARD NASS, JACK SHANDLE, AND SHERRIE VAN TYLE

The special needs of engineers and engineering managers who design portable equipment will come into sharp focus at the Portable By Design Conference. The conference, which will be held Feb. 14-18 in the Santa Clara Convention Center in Calif., offers a combination of technical sessions and workshops that span the breadth of design issues for portable products. These include the normal design and specification tasks for electronic hardware designers, such as power supplies, circuits, and choosing the right processor for a particular application.

But designing successful portable products also requires a high level of knowledge and understanding of other disciplines not usually within the hardware designer's domain.

To address these issues, upon which the product's success rises or falls, the conference has included technical sessions on software operating systems and applications development for portable systems; mechanical and industrial engineering topics that impact electronic design; and a special panel session on battery technology that allows plenty of time for questions and answers from battery experts.

In addition, there will be workshops that cover critical issues. Among them are dc-dc power conversion, ergonomics, regulatory issues in the European Community, accelerated product development, and how to design for compliance with EMI, RFI and ESD interference.

PICKING A PROCESSOR

Choosing the right processor for a portable product is far more challenging than flipping the pages of the Intel Corp.'s 80X86 applications notes. Personal Digital Assistants (PDAs), personal communicators, tablet computers, and the ever-increasing number of portable products for vertical applications all have different requirements.

The two technical sessions that cover processor technology will feature papers that discuss a wide range of options. Pramod Argade, of AT&T Bell Laboratories, Murray Hill, N.J., for example, will deliver a presentation on "Small-form-factor systems design considerations for personal communicators." The paper will reference members of the AT&T Hobbit chip family. The extendibility of the up-and-coming PowerPC architecture will be the subject of a presentation from Motorola and IBM titled "High-performance portable systems design based on the PowerPC."

A paper titled "Defining a PDA for vertical applications", to be presented by Mike Mori, Consulting Engineer, Vadem Inc., San Jose, Calif., will use the Sharp PT-9000 as an example. Other offbeat options for specific applications are described in papers titled "Reduce system clutter by combining DSP and control functions," by Phil Nash, National Semiconductor Corp., Santa Clara, Calif.; "Architectural design issues for a portable two-way radio," by Christopher Hale and Pierre Droilet, Motorola Inc., Austin, Texas; and "Managing power in battery-powered consumer goods," by James Goodhardt, Zilog Inc., Campbell, Calif.

The more conventional solutions will not be ignored, however. Papers from Motorola; Intel; Toshiba America; and Hitachi America, Semiconductor Div., will describe how to-

PORTABLE BY DESIGN CONFERENCE

February 14-18, 1994
TECHNICAL SESSIONS

Tuesday, Feb. 15		Wednesday, Feb. 16		Thursday, Feb. 17		Friday, Feb. 18	
8:00 a.m.- Noon		8:30 a.m. - Noon		8:30 a.m. - Noon		8:30 a.m. - Noon	
Processors Part I	Power Circuits	Software Part I	Power Management	Connectivity	Displays	Mechanical Engineering II	PCMCIA
1:30 p.m. - 5:30 p.m.		1:30 p.m. - 5:30 p.m.		1:30 a.m. - 5:30 p.m.		1:30 p.m. 5:30 p.m.	
Processors Part II	No Session	Software Part II	Battery Technology	Input Devices	Mechanical Engineering	No Sessions	

day's high-profile processors can be integrated into portable products.

POWER-RELATED ISSUES

Power and power management are crucial design problems in portable equipment, and the conference has set aside three sessions to address them. Among the seven papers in the Power Circuits Session is one by Jim Williams, staff scientist, Linear Technology Corp., Milpitas, Calif., who will speak on "Techniques for 92%-efficient LCD illumination." David Shiels of CSEM S.A., Neuchatel, Switzerland, will reveal the techniques used in low-voltage circuits for watches in a presentation titled "Low-power ASIC techniques for battery-powered applications." Paul Greenland of Allegro Microsystems Inc., Worcester, Mass., and I. Yokohama of Sanken Electrick Co. Ltd., Tokyo, Japan, will discuss "The low-drop linear regulator: key to successful battery management."

Also in the Power Circuits Session, Chester Simpson of National Semiconductor Corp. will expound on "Power-supply design methods for battery powered systems". And Bruce Moore of Maxim Integrated Circuits, Sunnyvale, Calif., will deliver a paper titled "System-engineered portable power supplies marry improved performance and cost."

The Power Management Session, which will be held on Feb. 16, picks up where the Power Circuits Session leaves off. Chaired by Barry Signoretti, principal applications engineer at National Semiconductor Corp., the session will delve into the secrets of conserving power from a system level. The speakers include Simon Ellis, manager of software engineering for the mobile computing group at Intel Corp., Santa Clara, Calif.; John Hull, product manager at Hitachi America Ltd., Brisbane, Calif.; Brian Martin, a design engineer at Philips Semiconductors, Sunnyvale, Calif.; Charles Melear, manager of advanced microcontroller applications at Motorola Inc., Austin, Texas; and Jim Walsh, a systems engineer at Texas Instruments, Dallas.

Ellis will discuss power management from a software perspective. The highlights include program control, active versus idle power management, and in-box versus add-on control. He will conclude with a sample design implementation.

Hull will look at how smart power management can extend portable-system battery life. As processing speeds increase and overall package size remains the same or shrinks, it becomes more difficult to manage the finite charge available from a battery. The presentation will review the history of power management from both the hardware and software perspectives, and discuss how the keyboard controller offers a series of options when implementing

PORTABLE BY DESIGN CONFERENCE WORKSHOPS

MONDAY, FEB. 14, 1994

Full Day Workshops

Accelerated Product Development

- Establishing reasonable goals for the project
- The not-invented-here syndrome
- Why everybody does not buy into a common product vision
- Functional organizations and project control
- The need for a working prototype early in the schedule

Design and Implementation of DC-DC Converters for Battery-Powered Applications

- An overview of common topologies
- Selecting a topology to match the application
- Designing, selecting and specifying magnetic components
- Thermal management
- Sources of noise and EMI
- Proper pc-board layout of power converters
- Testing and troubleshooting converter circuits

Half-Day Workshops

How Ergonomics and Industrial Design Impact Electronic Subsystems

- Anthropometrics
- Safety issues and agency standards
- Human/computer interface design
- User testing for design validation
- A case study using a high-profile portable product

Regulatory Issues for Portable Systems Marketed in the EC

- Requirements for compliance
- Optional routes for attaining compliance
- Strategies for managing resources
- The importance of starting early
- Special requirements of portable equipment

TUESDAY, FEB. 15, 1994

Full-Day Workshop

Designing for Internal and External Interference Problems, Including EMI, RFI and ESD

- The physics of EMI
- Characteristics of passive components (the hidden schematic)
- Grounding
- Interconnections
- Power supplies
- Shielding

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Making the transition from 5- to 3-V power supplies allows system designers to reduce power consumption, lower EMF levels, and use faster and denser ICs. However, because it will take some time for every element of a sophisticated system to become available in 3.3-V versions, hybrid systems using both 3- and 5-V power supplies will become common. There are some tricks to ease the transition, as Martin will explain. He will also discuss the reliability issues that coincide with the hybrid systems.

"Power-management techniques in modular microcontrollers" is the title for Melear's presentation, which goes into several methods of reducing the power consumption of microcontroller circuits using a modular construction. For example, the operating system or applications software can help invoke the power-saving modes. Voltage can also be reduced, thus limiting the maximum clock rate of the MCU. The presentation will take an actual design example and show different implementations for different sets of conditions.

Power-saving mode transitioning and how it applies to portable system design will be the topic of Walsh's presentation. He will detail the issues and options associated with transitioning a portable platform between normal, screen-blank, standby, and suspend modes. The discussion will conclude by detailing power-supply issues.

BATTERIES

The Batteries Session is segmented into two parts. The first will be a panel discussion that includes an overview, technology presentations, and a question-and-answer period involving representatives from major battery manufacturers. The second session will comprise several papers on battery technology and battery-management techniques.

The panel discussion will be led by session chair K. Fred Wehmeyer, director of chemical technology at Portable Energy Products, Scotts Valley, Calif. The overview, presented by Wehmeyer, will compare today's leading chemical systems by rating them all for a specific portable application by their key parameters.

Following the overview, panelists from such manufacturers as AER Energy Resources Inc., Smyrna, Ga.; Duracell Inc. Bethel, Conn.; Energizer Power Systems, Gainesville, Fla.; and Rayovac Corp., Madison, Wis., will give short presentations on their chemical technologies, providing perspective on their applications in portable equipment.

In the session's second half, papers will address battery-management techniques as well as an overview of battery technology from the point of view of a manufacturer. David Heacock and David Freeman of Benchmarq Microelectronics Inc., Carrollton, Texas, will describe how battery characteristics vary greatly under environmental and usage conditions. These variations increase the complexity of system designs. The authors will conclude with design recommendations based on system reliability, accuracy, and cost.

The requirements for intelligent battery management will be among those discussed in a paper by Jim Nolan of Microchip Technology, Chandler, Ariz. A specific case history will demonstrate how systems based on digital MCUs, rather than analog implementations, provide the most accurate and flexible approach to battery management.

A survey of battery technology will be conducted by Motorola's Charles Melear. Melear will examine the currently available battery technologies and emphasize the advantages and disadvantages of each. Experimental battery technologies also will be included.

SPECIAL TOPICS

It's become essential for engineers who design the electronic subsystems of portable equipment to work more closely with their software and mechanical engineering colleagues. To address this issue, four sessions have been set up to provide an overview of what EEs need to know about these topics.

The two Software Sessions will consider the design implications of both the operating-system selection and applications development. The operating-systems session is being chaired by Christopher Minson, group manager for Messaging Products, EO Inc., Mountain View, Calif. The object of the session is to introduce the audience to various operating-system types for different applications, including mobile, pen input, and keyboard input. Presentations will be made by speakers from GeoWorks, Berkeley, California; Microsoft Corp., Redmond, Wash.; and other leaders in the OS field.

The applications-development session, chaired by Richard C. Roistacher, President, Belmont Associates, Belmont, Calif., will focus on two aspects of applications for portable products. Because hardware designers are not, for the most part, acquainted with the software capabilities of portable systems, Pi Systems, Portland, Ore., will demonstrate some of the portable products it has developed for vertical applications in hospitals and health care. A presentation of a horizontal application will be given by EO.

Technical papers in the applications-development session will address how to write applications for specific portable modalities. One such paper comes from Bob Smith, president of Wireless Connect, Santa Clara, Calif., who will describe the special problems and solutions for writing applications tht address digital-packet-radio as a transmission mode.

Although many electronic-engineering oriented sessions will address issues on a nuts-and-bolts level, the two on mechanical engineering home in on higher-level topics. Dennis Boyle, a senior engineer at IDEO Product Development, Palo Alto, Calif., and Scott Hickman, a design engineer at Hewlett-Packard Co.'s Corvallis, Ore., division, will cochair the sessions. Included among the 12 papers are: "Designing and manufacturing in a global context" by Lauren Lundquist, manager of mechanical design, Frog Design Inc., Menlo Park, Calif.; "Cross-functional innovation in product-development teams," by Andy Hargadon, Stanford University; and "How am I doing on time-focused product development?" by Ron Kmetovicz, president, Time To Market Associates, Verdi, Nev. Other topics will cover thermal design, EMI/RFI

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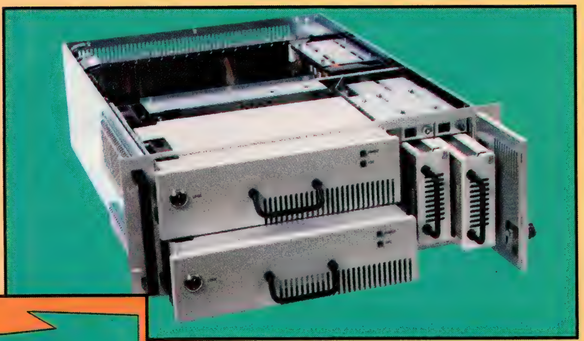

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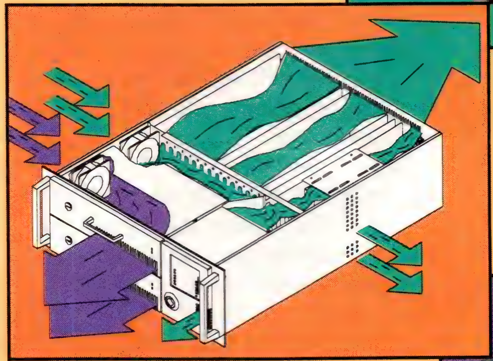

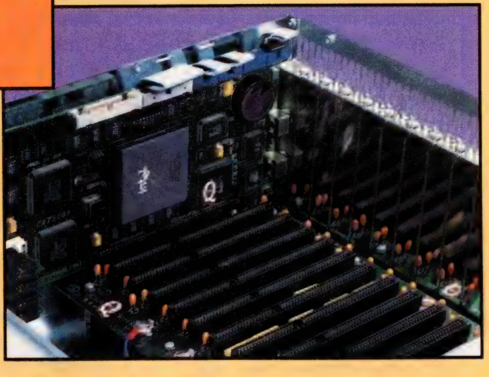

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SYSTEM-RELATED ISSUES

Three Portable by Design sessions are devoted to components and subsystems, which play an increasing key role in portable systems. The Displays Session, chaired by Steve Sedaker, senior field applications engineer at Sharp Microelectronics, Camas, Wash., will investigate five key areas. Converting dc power from batteries to ac power that runs the fluorescent backlights for LCD displays is still something of an art, and the consequences in terms of shortened display life can be severe. John Peterson, chief engineer, Endicott Research Group, Endicott, N.Y., will discuss the design trade-offs in a paper titled "The use, validation, and control of fluorescent tubes used to backlight LCD displays." In a paper related to the same general topic, Dave Bell, senior engineer, IDEO Product Development, will discuss the "Tradeoffs between EL and cold-cathode backlighting for LCD displays." In addition, Bob Conner, applications engineer, Cirrus Logic Inc., Fremont, Calif., will discuss a controller chip for 800-by-600-pixel, 256,000-color thin-film-transistor (TFT) displays. Paul Gilick, chief technical officer, Motif Inc., Wilsonville, Ore., will explain a relatively new and power-efficient technology that allows active addressing of passive-matrix displays.

The Input Devices Session, chaired by John Murphy, president of J. Murphy Co., Santa Clara, Calif., will center on the many different types of system input. They range from pen input to bar-code scanners and other portable-type alternatives.

The presentations will be made by Scott Hansen, president of Kalidor Inc., Upland, Calif.; Robert Kable, vice president of engineering at Scriptel Corp., Columbus, Ohio; Luis Figarella of United Parcel Service (UPS), Danbury, Ct.; as well as Inforite Corp., San Mateo, Calif.

The MaxiCode bar-code-scanning technique will highlight Figarella's presentation. UPS recently patented the two-dimensional technology that replaces one-dimensional bar-code labels currently in use. MaxiCode contains considerably more information than found in current implementations and can be read more accurately by the scanner. The codes are read on packages passing at a high speed, up to 500 ft./min., in any direction and at virtually any angle.

End-user productivity is always a concern to designers of portable systems. Hansen will elaborate on this topic, with a slant toward pen computing.

Kable will tackle the issues surrounding digitizers. He says that the color LCDs found in today's laptops create high-frequency noise that makes character recognition and other pen-based functions difficult. His presentation will highlight some of the ways to get around those problems, as well as some others that might crop up.

Five presentations are scheduled for the Expandability and Configurability (PCMCIA) Session. They will be given by Niteen Bhat, applications engineer at SunDisk Corp., Santa Clara, Calif.; Bob Conn, president and chief engineer of Connsult Inc., San Jose, Calif.; Joel Levine, vice president of marketing at SyQuest Technology, Fremont, Calif.; Robert Schneider, president of SCM Microsystems Inc., Los Gatos, Calif.; and Jeff White, an OEM channel manager for mobile computing at Hewlett-Packard Co., Boise, Idaho. The session will be chaired by John Reimer, president and CEO of SCM Microsystems.

Bhat's presentation, "Incorporating PCMCIA ATA into an embedded design," will cover the issues surrounding low power, ruggedness, removability, and interoperability as they pertain to the PCMCIA ATA standard. The presentation will follow the discussion on a typical embedded design, including all hardware and software issues.

Conn will look at one of the more unique applications of PCMCIA: a global positioning system (GPS) in a hot-air balloon. Over a two-week period, the GPS was integrated with a topographical map of Luxembourg using PCMCIA as the media map. The PCMCIA alternative was required for size and power.

Covering mass storage for mobile computing, Levine will discuss the mobile applications that require mass storage, then go into the use of PCMCIA as an enabling technology. The different options that are available for PCMCIA storage, as well as plug-and-play capabilities, are addressed. It will conclude with a discussion on future trends in this fast-paced industry.

Schneider will take an in-depth look at two specific portable designs that employ PCMCIA-based flash cards. The first is a medical instrument, built with an 8051 microcontroller, that can record 15 different parameters by monitoring a patient. The data is stored on the flash card, then transmitted for analysis. The reasons for choosing flash over other architectures will be discussed.

Schneider's second topic covers an embedded PC mounted in a truck. The design employs an Intel 80C186, ROM, DOS, and a proprietary flash file system. Mass storage is handled through flash memory in an industry-standard PCMCIA card.

HP's White will discuss different applications for the rugged 1.3-in. Kittyhawk personal storage module. The device addresses the needs of the electronic handheld computer market. He will also shine some light on the methods of embedding the unit within a portable system.

The Connectivity Session will explore several of the key communications technologies that can be useful in portable systems, including infrared, cellular, spread-spectrum, Personal Communications Services (PCS), and cellular packet radio technologies. Bob White, director of PCS services and architecture at Bellcore, Red Bank, N.J., will present a paper explaining how to design for the coming PCS infrastructure. Another example is highlighted in a paper on the IRDA serial infrared interface standard, which will be presented by Mike Cheponis, chief technical officer, California Wireless Inc., Santa Clara, Calif.

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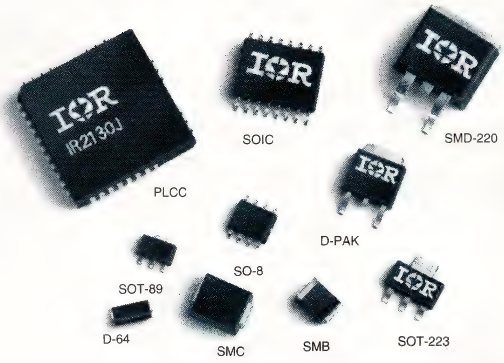

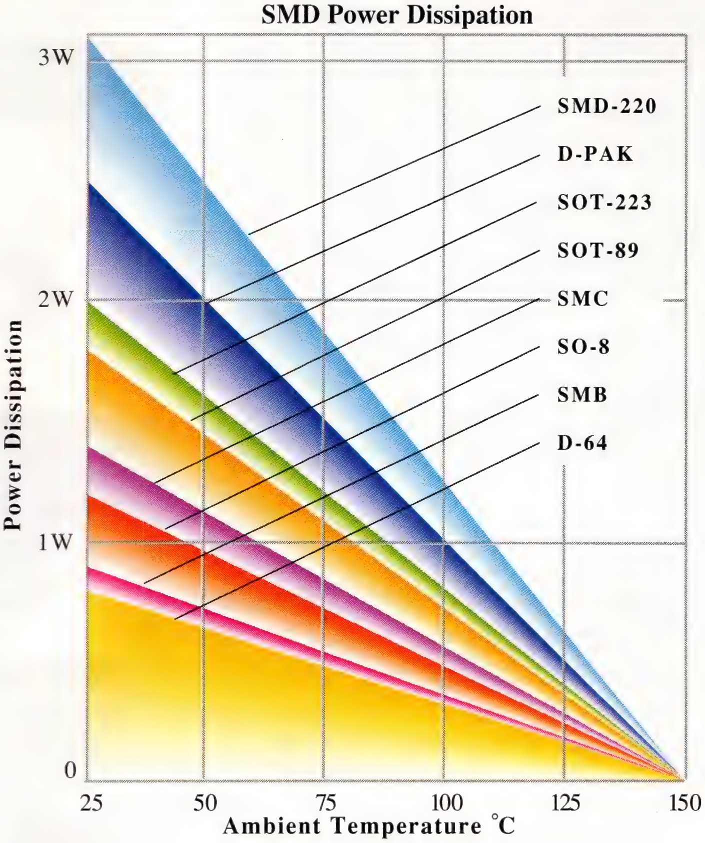

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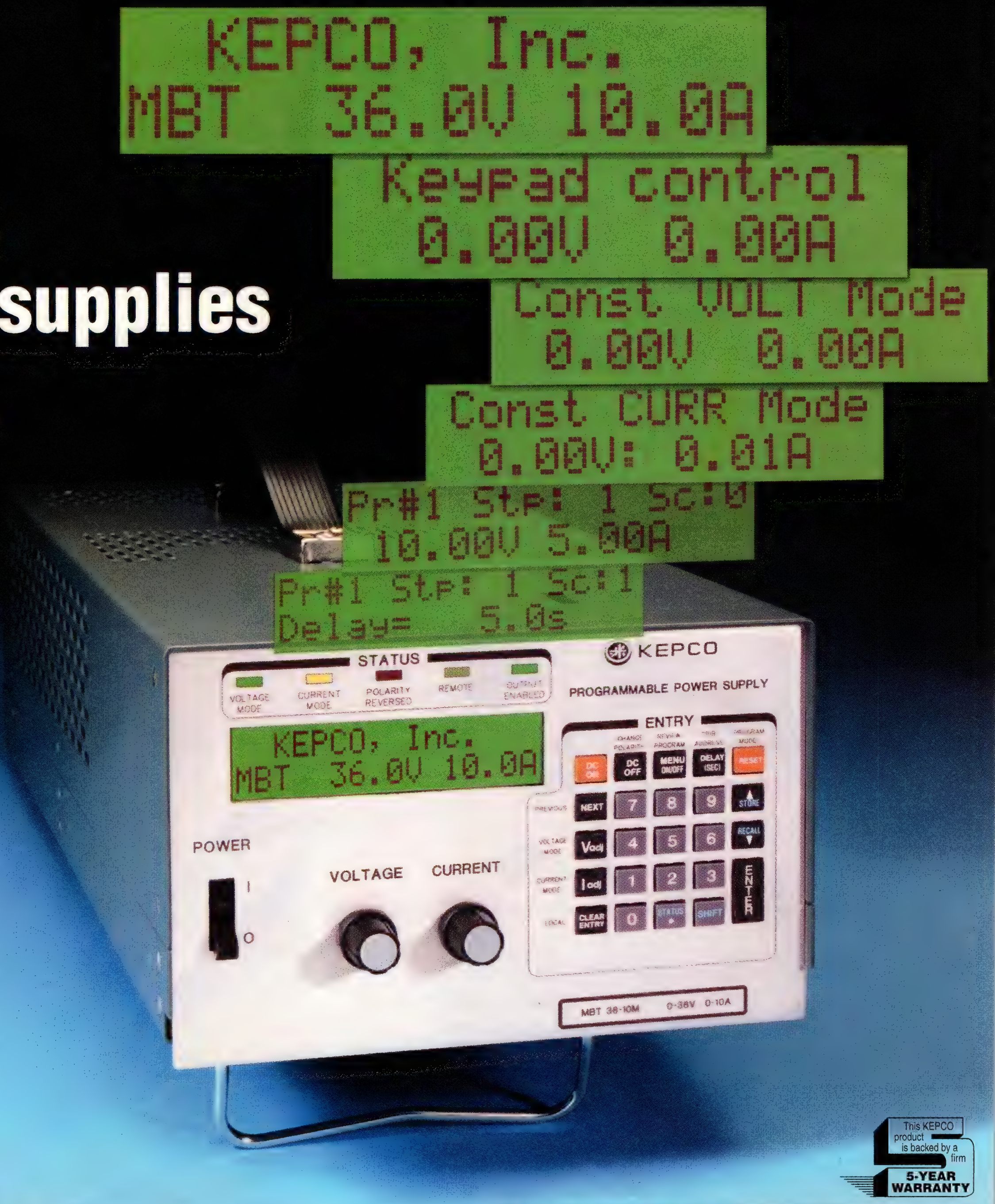

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MBT 25-14MG	0-25	0-14
MBT 36-10MG	0-36	0-10
MBT 55-7MG	0-55	0-7
MBT 75-5MG	0-75	0-5
MBT 100-3.6MG	0-100	0-3.6
MBT 150-2.4MG	0-150	0-2.4

A single board computer is included in models with suffix "G". This enables the RS 232 & GPIB (IEEE 488.2) ports and allows an MBT to act as a "master" driving other power supplies. Models are available without the G for use as "slave" units and stand-alone service. To include the Output Enable and Polarity Reversal relays, add a suffix "R" to the model number.

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A ONE-CHIP ETHERNET AND SCSI DEVICE FOR PCI-BUS COMPUTERS ELIMINATES THE NEED FOR COSTLY, SLOT-CONSUMING ADAPTER BOARDS.

JOHN NOVELLINO

The speed demon known as the PCI bus has arrived with a bang. That fact was driven home at last November's Comdex show, where a passel of products incorporating the PCI (Peripheral Component Interconnect) local bus made their debut. To take maximum advantage of PCI, however, users will want to employ SCSI, the I/O interface recommended by the PCI standard, and Ethernet, the dominant standard in PC-based networks.

Fortunately, a one-chip replacement for SCSI and Ethernet adapter boards now makes those two interfaces practical and affordable for any user who really needs the speed advantage supplied by the PCI bus. The PCnet-SCSI IC, which comes in a 132-pin plastic quad flat pack a little more than 1 in. by 1 in., allows computer manufacturers to design SCSI and Ethernet into as little as 4 in.^{2} on a motherboard. The result is a lower-cost solution that not only saves space, but also reduces the number of loads required on the local bus.

To optimize performance, Advanced Micro Devices designed the PCnet-SCSI for use exclusively on the PCI bus—a standard local bus that targets the traditional I/O bottleneck between a computer's CPU and its peripherals. PCI's 32-bit data path and 33-MHz clock speed move data at 132 Mbytes/s, compared with the ISA bus' 5-Mbyte/s rate.

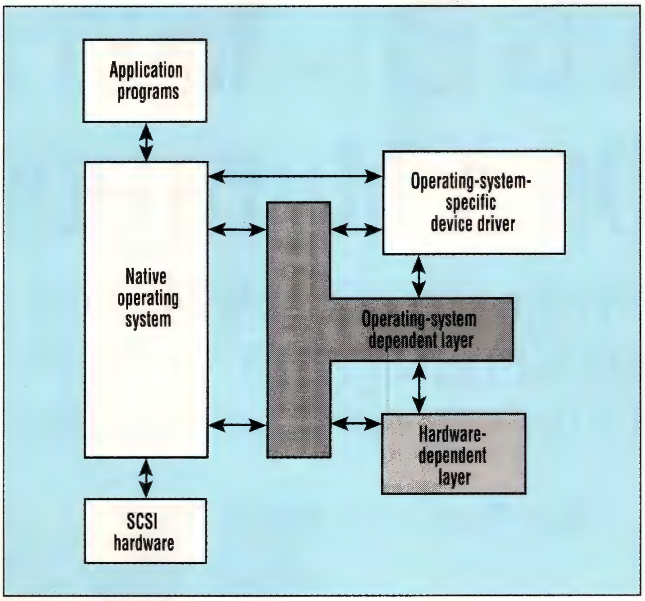
In addition, AMD sees the PCI bus as the wave of the future for high-performance personal computers. "We think PCI will ship 5 million units this year, its first year of volume production," says John M. Monti, a product marketing manager in AMD's I/O and Network Products Div. "In fact, the volume for

PCI should reach 30 million in a few years. That's why we're investing so much money in it. We think it will dominate the high end."

Because the PCnet-SCSI is a bus-master device, the chip can take command of the PCI bus to transfer Ethernet network traffic or SCSI peripheral data in quick bursts. Slave devices performing the same transfers must continually interrupt the traffic on the bus, raising bus and CPU usage and hurting overall system performance.

According to AMD, integrating the PCnet-SCSI on a motherboard will cost about $40, which compares to about $100 for an Ethernet adapter board and about $200 for a SCSI adapter. In addition, many end users have to hire someone to install the adapters.

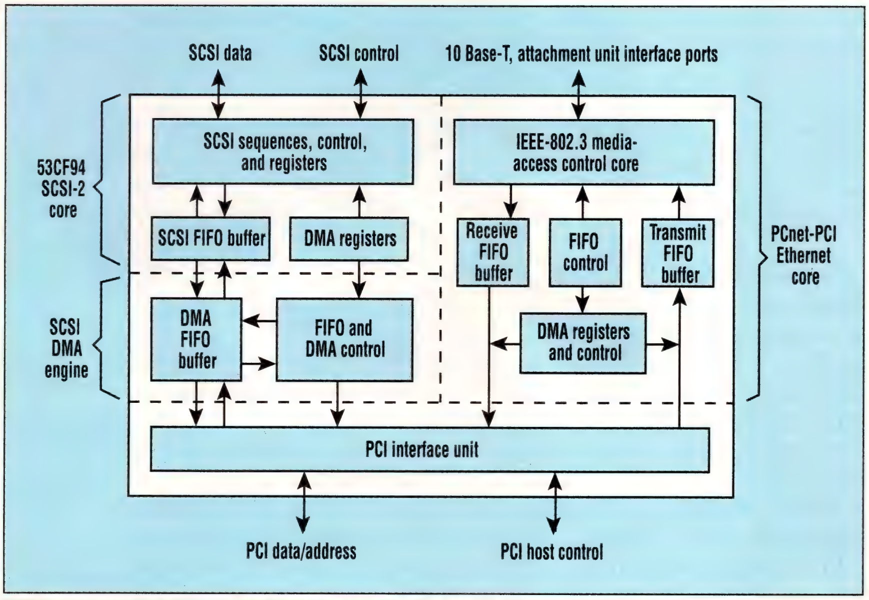
The PCnet-SCSI is the only active device required for both interfaces. All physical drivers for PCI, SCSI, and 10Base-T Ethernet are included. Several passive components must be added to the motherboard. The SCSI standard requires a fuse, a diode, and terminators. Ethernet needs a filter for 10Base-T and an EEPROM to store the node address. Of course, connectors also are required. The whole package should easily fit in 4 in.^{2}, says Monti.



2. A TWO-LAYER SOFTWARE architecture, in which functions dependent on the operating system are separated from those dependent on the hardware system, reduces the time needed to develop and test software updates and upgrades.

Perhaps more important than cost in many applications is the fact that the chip cuts the number of PCI loads needed. The PCI bus can accept 10 loads. Each chip on the motherboard acts as one load, and each board plugged into a bus slot counts as two loads. The conventional implementation of PCI uses a three-chip set. A bus arbiter typically must be added if the system is to have more than one master device, which would usually be the case in a PCI-based computer. Therefore, the first four loads are dedicated to PCI itself.

Separate Ethernet and SCSI adapter boards would occupy four of the six remaining loads. Separate motherboard-based chips would take up two loads. But the PCnet-SCSI, which incorporates only one PCI bus interface, acts as only one load. "We think that one of the big advantages to having a combination chip is that it only takes one load," says Monti.



1. THE PCnet-SCSI CHIP IS BASED ON existing SCSI and Ethernet adapter cores. However, new scatter-gather DMA engines were designed for each function to improve I/O transfer rates.

Users should experience no performance compromises caused by having both functions on one chip, notes Monti. Everything on the die is completely independent except for the use of only one PCI-bus interface. But just one master can control the PCI bus at one time, so the single interface doesn't create any trade-offs.

In fact, both SCSI and Ethernet can operate as independently as if they were two separate devices on the bus. The system can receive Ethernet packets into the chip's FIFO buffer while the SCSI is transferring data across PCI into memory. Or, SCSI can send and receive data while Ethernet unloads its FIFO buffer across PCI. "These are things we've tested in our lab and verified," says Monti.

A prospective customer, thinking that the combination chip would create some penalty in recovery time, asked AMD how quickly the device could switch between Ethernet and SCSI. "In fact, our recovery time is a single clock, or 30 ns, which is the fastest that can be done," says Monti. "In other words, we can end an Ethernet transfer and start a SCSI transfer on PCI as fast as two separate devices can. So we don't think there are any performance compromises."

The PCnet-SCSI's two main sections are based on existing Ethernet and SCSI cores previously introduced by AMD as separate devices. Significant modifications and additions had to be made, however. The Ethernet controller on the chip was expanded from 16 bits to 32 bits to accommodate the wider PCI bus. The result was a change from the PCnet-ISA chip to the PCnet-PCI device, which is an Ethernet-only con-

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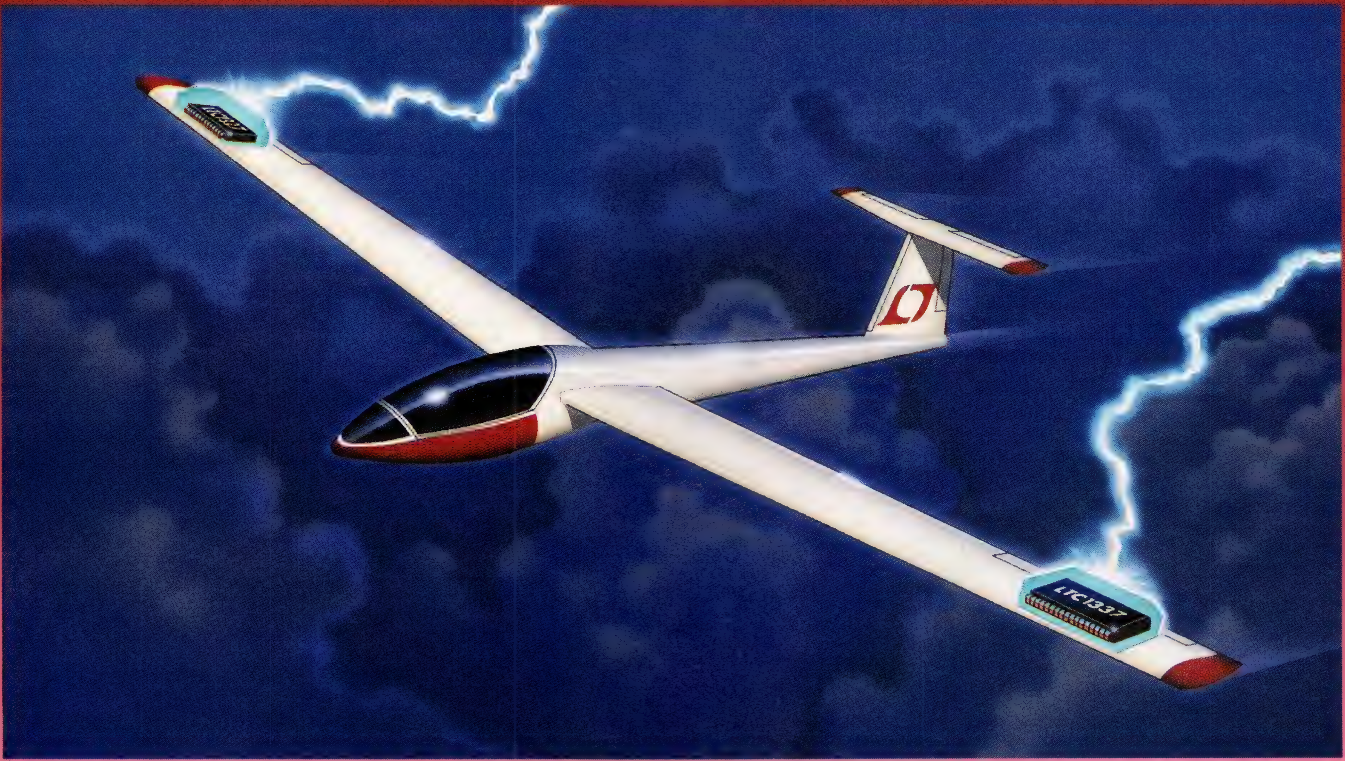

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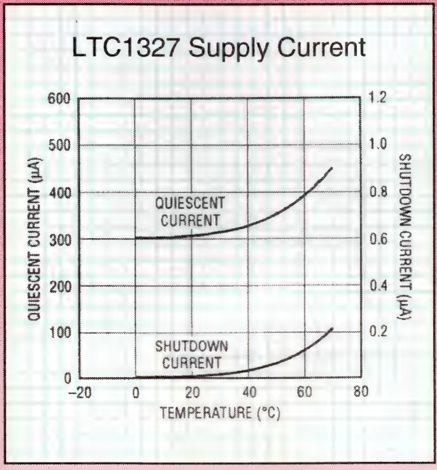

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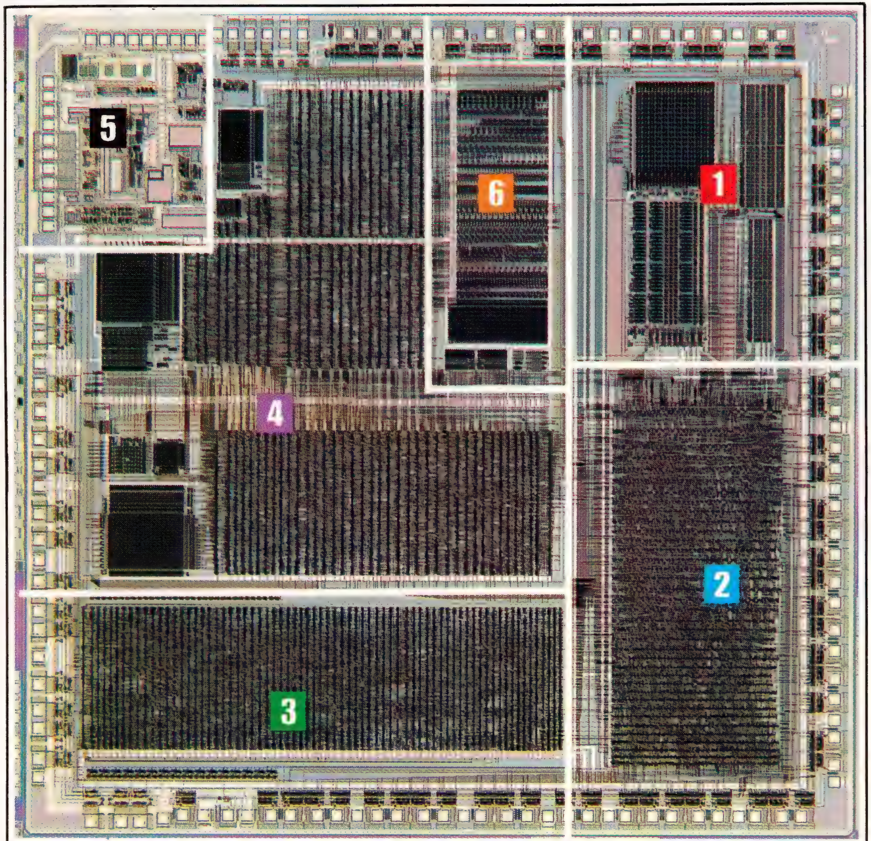
troller. PCnet-SCSI is software-compatible with PCnet-PCI.

On the SCSI side, AMD used the core from the 53CF94, a standard Fast SCSI-2 slave device. No modifications were made to that core, but a new DMA engine was designed so that the SCSI controller could become a bus master on the PCI.

The chip is a low-power (5-V) CMOS VLSI device. The Ethernet portion of the chip holds an IEEE-802.3 media-access control function that includes an attachment-interface unit and a 10Base-T media attachment unit *(Fig. 1)*. Also on the Ethernet side are separate 136-byte transmit and 128-byte receive FIFO buffers and a DMA buffer-management unit. The chip's Ethernet function is fully compatible with Novell NE2100/1500T adapter cards.

The SCSI-2 core supplies an 8-bit interface that supports a single-ended SCSI with a 10-Mbyte/s transfer rate. The DMA engine, a scatter-gather design, includes a 96-byte FIFO buffer that allows 32-bit memory transfers in a burst mode across the PCI bus at the bus' maximum speed of 132 Mbytes/s. The PCI interface unit contains configuration space and a PCI master/slave interface as defined by the PCI Revision 2.0 specification.



1 SCSI DMA FIFO buffer and PCI configuration space and control logic

2 SCSI DMA controller and PCI interface

3 53CF94 SCSI-2 core

4 Ethernet core with transmit and receive FIFO buffers

5 Ethernet 10Base-T, attachment unit interface (analog I/O)

6 Ethernet bus management unit and control and status registers

3. THE SCSI-ETHERNET ADAPTER IC contains a significant amount of analog circuitry to accommodate the Ethernet function. Layout was also critical because the possibility of three buses operating at once created a potentially large noise problem.

The DMA engine designed for the PCnet-SCSI is based on a Microsoft hardware model that can be optimized for the Windows NT operating system. The scatter-gather translation technique used by the engine makes possible faster I/O transfers. The technique employs a list of page frame addresses stored in system main memory, otherwise known as a memory descriptor list (MDL). The MDL allows a single SCSI transfer to read from or write to noncontiguous address memory locations. This scheme eliminates the need to copy the transfer data and MDL locations, which is required for conventional DMA operations.

Although both portions of the PCnet-SCSI IC use a scatter-gather technique, AMD had to optimize the two DMA engines differently because of the differences between Ethernet and SCSI. One reason is that SCSI usually involves transferring large blocks of data, while Ethernet transfers much smaller data blocks but has lots more overhead.

NO I/O PROCESSOR NEEDED

Noting that some SCSI controllers include a complicated state machine or processor, Monti said AMD gave the question of on-board intelligence some thought before electing not to place such circuitry on the PCnet-SCSI. "We think the birth of PCI has obsoleted the need to put processors on I/O controllers," he says. "On a much slower expansion bus, like ISA, it was important to have a processor on the chip or on the adapter card because you didn't want control of the SCSI function to come from the CPU over the ISA bus. That's what makes most SCSI ports really slow today, the fact that they depend on the system CPU sending commands over the ISA bus."

But PCI's high speed and low interrupt latency make the power of the system CPU available to I/O controllers. "The central CPU can control everything now because PCI is so fast and has such low latency," Monti says. "That's why we elected not to put a processor on our chip. We think it would have been redundant to do so."

He notes that the PCnet-SCSI has

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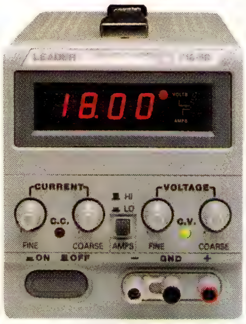
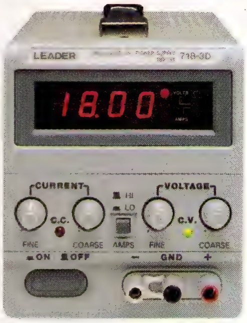


18V 3A



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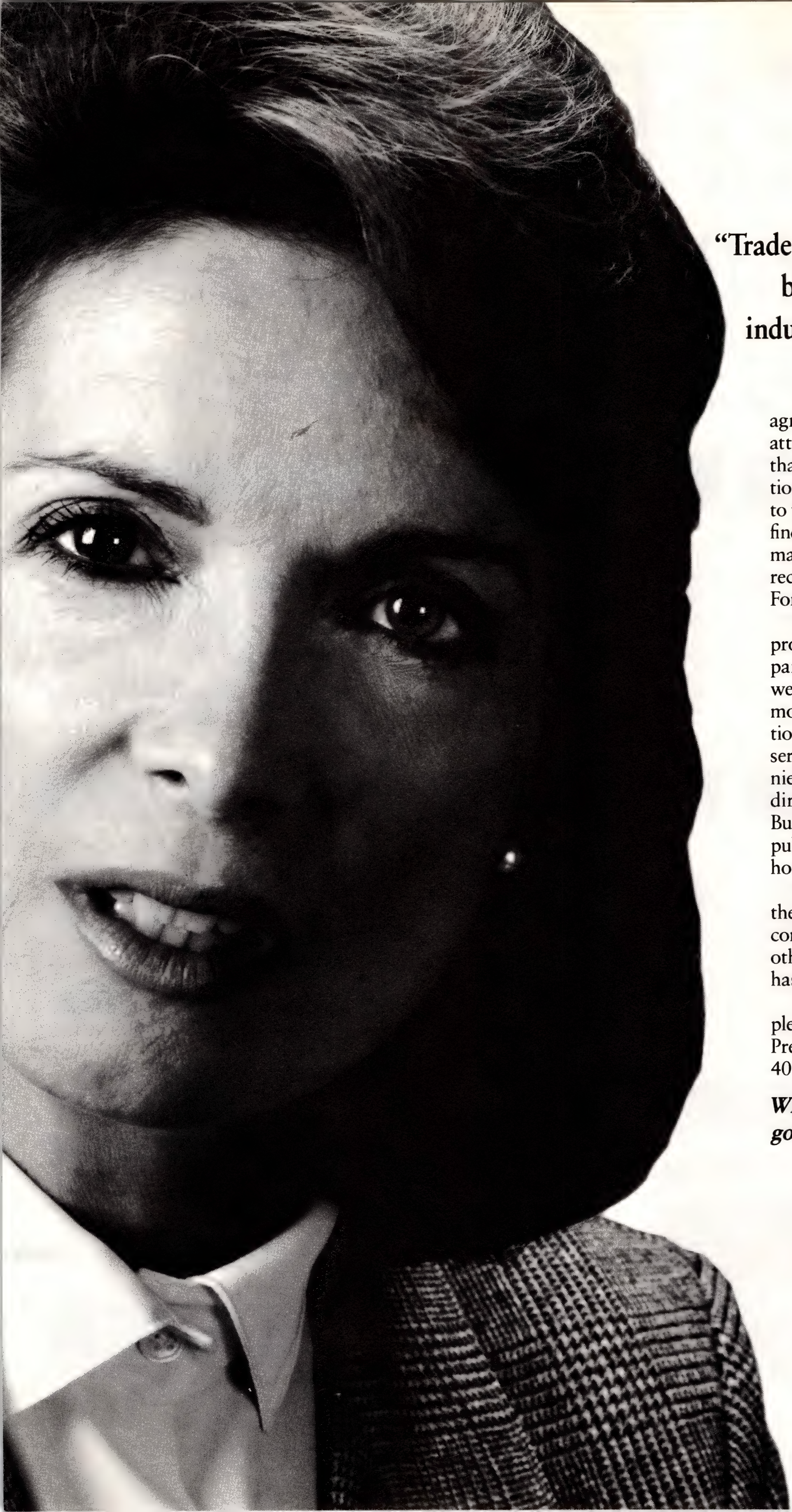

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two significantly enhanced DMA controllers: "So it's not to say that the chip's a dumb device. It does have the intelligence that we think it required, and that is scatter-gather DMA for both Ethernet and SCSI." Benchmark measurements run by AMD show that the PCnet-SCSI performs comparably with devices that include an on-board processor, while costing less because of the smaller silicon area needed.

According to Monti, a significant amount of effort—and about half the development costs—of the PCnet-SCSI project went into software. Separate suites of drivers had to be developed for the Ethernet and SCSI functions. "We used an overall hierarchical architecture for our drivers from the beginning so that now they're all very portable and compatible," he says.

The drivers support all popular network operating systems and SCSI peripherals. For SCSI, operating systems include DOS 5.0-6.0, Windows 3.1 (FastDisk), Windows NT, Novell Netware 3.X and 4.X, SCO Unix 3.2.4 (with Open-Desktop 2.0), and IBM OS/2.X. For Ethernet, the list includes Novell NetWare and NetWare Lite; Microsoft LAN Manager, Windows NT, and Windows for Workgroups; SCO Unix; DEC Pathworks; Artisoft LANtastic; IBM LANserver; and Banyan Vines.

Manufacturers designing PCnet-SCSI into their systems pay a nominal one-time fee to get the software and unlimited royalty-free distribution rights. AMD will maintain and upgrade the drivers.

The drivers, written in C, are designed around a two-layer architecture that separates functions dependent on the operating system from those dependent on the hardware *(Fig. 2)*. The hardware-dependent layer supplies the low-level programming for the SCSI protocol. The operating-system layer acts as a manager for the hardware layer, providing functions it needs to execute requests. The operating-system layer also supplies DMA services, request completion, interrupt services, memory allocation, and I/O port and address translation.

This design is based on the Microsoft Windows NT Miniport driver model, but is applied across all PC operating systems. Separating the operating system and hardware dependencies within each driver allows faster development and testing of updates and upgrades.

ELIMINATING NOISE

The PCnet-SCSI chip has two features aimed at cutting noise and increasing reliability during SCSI operations. One is the patented Glitch Eater circuitry, which users can program to filter out glitches with widths of up to 35 ns (the default width is 12 ns). The technique is implemented on the Request and Acknowledge lines that perform the handshake required for each byte of data going across SCSI. These lines are most susceptible to electrical anomalies like reflections and voltage spikes, which can trigger false handshakes, false data transfers, the addition of random data, and double clocking. When activated, Glitch Eater changes certain setup and hold times, but they remain within specified limits for SCSI-2.

Reduced noise and greater reliability is also provided by programmable active negation. When implemented by the user, active negation drives the Request, Acknowledge, and SCSI Data lines to a high state (which is off because SCSI uses negative logic). By doing so, active negation increases the speed of the transition, eliminating unwanted signal transitions and associated double clocking of data.

Active negation is based on the fact that the SCSI bus is a transmission line which requires terminators, usually in the form of resistor packs on each end. As a result, SCSI devices aren't required to turn themselves off. They can just stop driving the signal and the terminator will pull the signal off. But this takes time, and the resulting ramp voltage can hurt system performance. What AMD did was add transistors to the output to pull the signal part of the way off. Once the signal is past the threshold point, the active-negation circuitry lets go and the terminating resistance pulls the signal the rest of the way.

This "jump start" can improve performance for synchronous SCSI operations when users are transferring many bytes in succession. This is particularly true for fast SCSI, which allows synchronous-mode transfers at up to 10 Mbytes/s.

AMD also strengthened the PCnet-SCSI's electrostatic discharge (ESD) protection. This is important for a one-chip solution because the device is basically attached directly to the connector's pins external to the computer. Improper handling of those pins could send a high ESD voltage right to the chip.

Putting the individual pieces of circuitry together onto one chip was not a trivial task, notes Monti. "This is a very difficult thing to do," he says. "This is why we think we're going to have a big advantage for probably the first year we're out." The two main problems involved the need for a mixed-signal process and potential noise problems caused by the chip's multiple buses.

The analog capability is needed for the 10Base-T transceiver circuitry in the chip's Ethernet section *(Fig. 3)*. AMD used expertise garnered from the design of an earlier Ethernet controller to ease the integration of the analog and digital technologies.

Bus layout posed a problem because the buses—PCI, Ethernet, and SCSI (with 48-mA high-current drivers)—can operate at once. "With the possibility of these things going at the same time, you must pay particular attention to die layout," says Monti. "You must make sure that you have proper grounds and that you locate the buses in separate planes in different places on the chip to decouple the noise from those three buses."☐

PRICE AND AVAILABILITY

The PCnet-SCSI (part number Am79C974) costs $39.95 each in quantities of 1000. Samples (in a 132-pin plastic quad flat pack) are available now. Volume shipments will begin in the second quarter.

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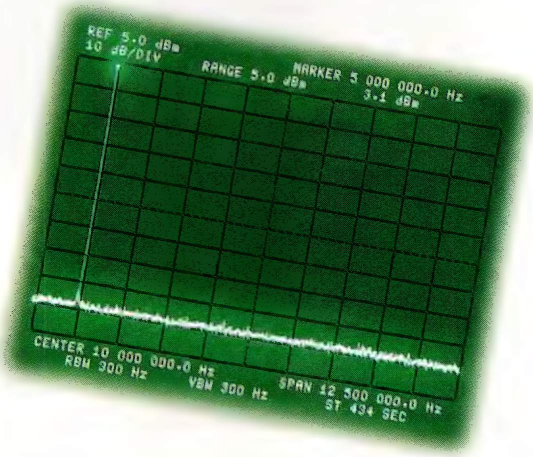

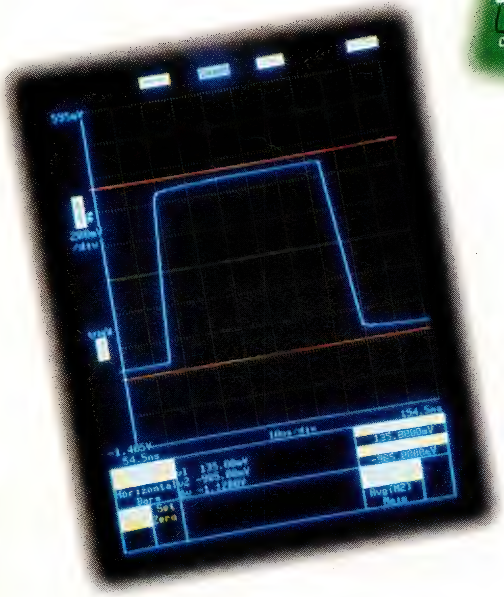

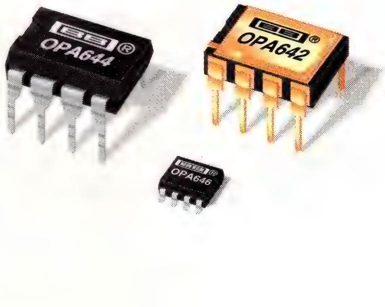

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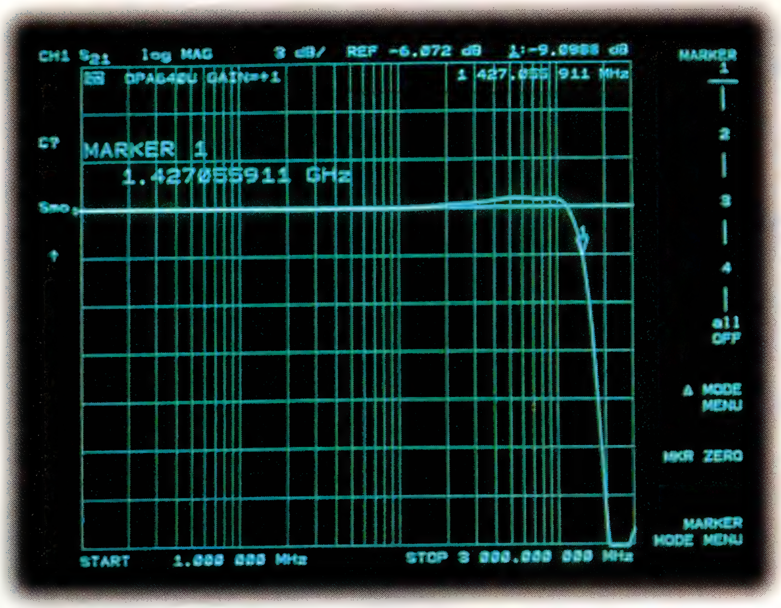

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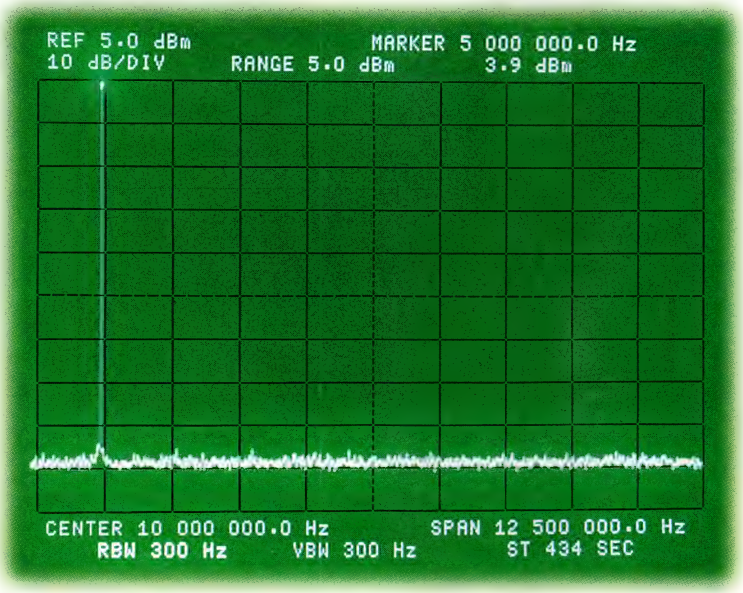

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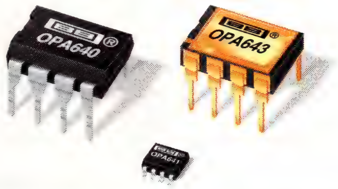

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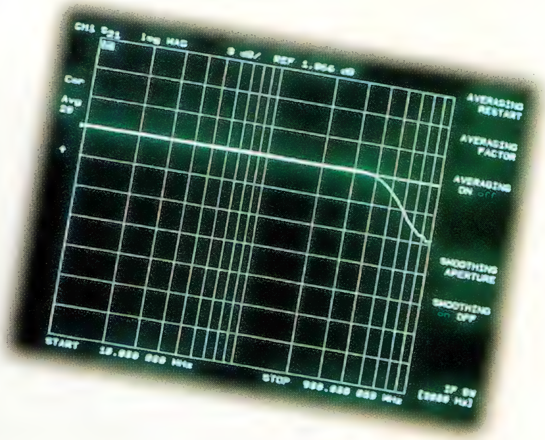

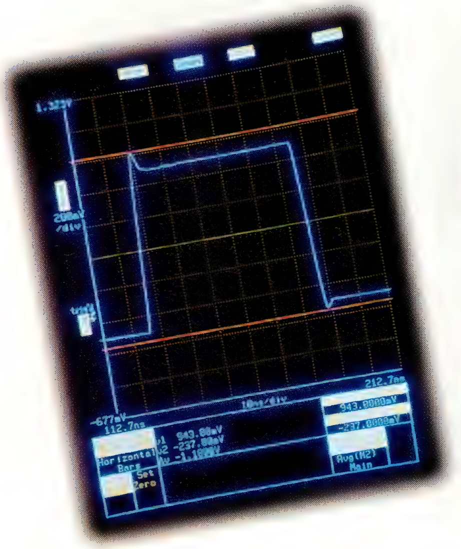

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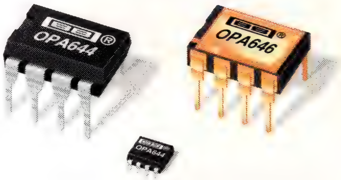

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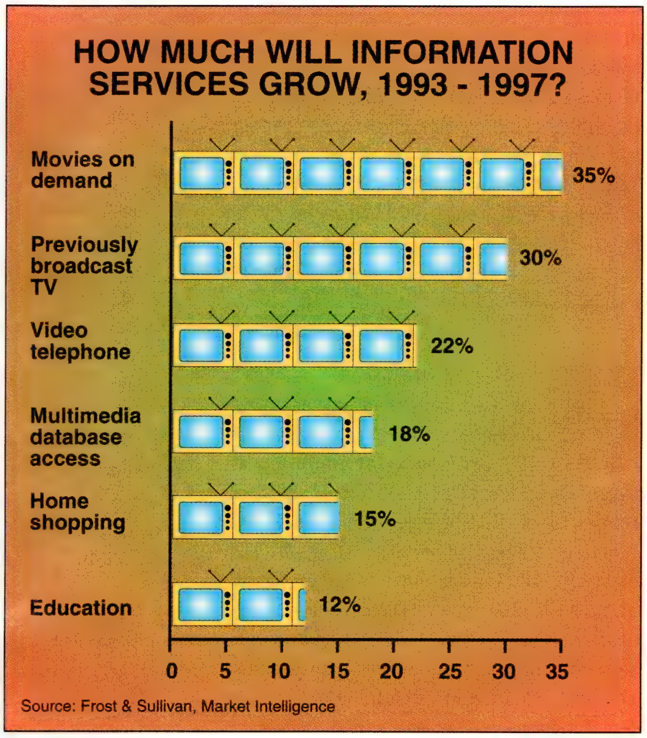
MARKET FACTS

The U. S. market for data communications and information services in residential and business markets is expected to grow from $17.9 billion in 1992 to $40.1 billion by 1997, according to a report from market researcher Frost & Sullivan Market Intelligence: *RBOC Strategies in Data Communications and RBOC Strategies in Information Services*. The regional holding company (RHC) share of this market will more than double, increasing from $9 billion this year to amount to more than $22 billion by 1997, estimates the Mountain View, Calif., company.

The importance of fiber is evident in the High Performance Computing Act of 1992, which sets out the goal of some day linking on a national data highway every business, home, and school in the U. S. Potential home information markets run the gamut of video on demand, interactive video, previously broadcast TV, home shopping, bill paying, and other services. Home management systems promise electronic control of appliances and security systems.

For regional Bell holding companies (RBOCs), deploying fiber in the local loop will become a strategic issue. If they invest heavily in deploying fiber, they may not see a payback for many years as the market for services gradually picks up speed. If they wait for broadband applications to mature, cable TV companies, mobile carriers, and interexchange carriers, will capture the lion's share of the market.



Source: Frost & Sullivan, Market Intelligence

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Hirose Electric Co. Ltd., a supplier of electronic and fiber-optic connectors, has become the first connector manufacturer in Japan to receive ISO 9001 certification for fiber-optic connectors, microwave devices, pc-board connections as well as various connector types: nylon, rectangular, IDC, circular, and coaxial. Contact Hirose Electric (USA) Inc., 2688 Westhills Court, Simi Valley, CA 93065; (805) 522-7958; fax -3217. CIRCLE 463

BICC VERO Electronics, a manufacturer of enclosures, backplanes, and other electronic products, has been certified to ISO 9002 for the manufacturing, assembly, and installation of racking systems, subracks, card cages, backplanes, and wired systems. The Hampshire, UK-based company's U. S. address is 1000 Sherman Ave., Hamden, CT 06514; (203) 288-8001; fax 287-0062. CIRCLE 464

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CIRCLE 469

The PC/104 Resource Guide, newly updated, is free to engineers developing embedded systems. The 120-page booklet includes an overview of the PC/104 standards, a cross-reference of PC/104-related products and functions, along with product listings from 75 of the PC/104 Consortium's member companies. The PC/104 standard (the basis for IEEE draft standard P996.1) defines a compact, self-stacking, modular form-factor for embedding IBM PC and PC/AT compatible system functions within embedded microcomputer applications.

Examples of these applications include vending machines, test equipment, medical instruments, communication devices, vehicular systems, data loggers, and industrial control subsystems. For more information, contact the PC/104 Consortium, 990 Almanor Ave., Sunnyvale, CA 94086; (408) 245-9348; fax (408) 720-1322. CIRCLE 470

NeoCAD, which supplies device-independent design tools for field-programmable gate arrays (FPGA) has a free disk that demonstrates NeoCAD's FPGA Foundry. This design environment supports multiple FPGA vendors and architectures, integrates into existing CAE environments, and supplies timing and frequency-driven design and performs post-mapped partitioning across multiple devices. The demo disk requires an IBM compatible PC and a VGA graphics display. For more information, contact NeoCAD, 2585 Central Avenue, Boulder, CO 80301; (800) 682-3143, ext. 107; (303) 442-9121, ext. 107; fax (303) 442-0198. CIRCLE 471

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
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Running a new product development effort at a staffing ratio of 0.5, or less is not acceptable in a competitive environment. As we have seen, doing so results in the loss of most of the product's lifetime profit. On the other hand, doing definition, planning, and execution work at a staffing ratio of 1.0, or greater, gets the product out and makes the money, but how do we make certain that commitment levels are not being exceeded? If commitment goes beyond a certain point, than adjustments to the staffing ratio must be properly implemented.

Work quantity/commitment = duration

We begin by examining the number of hours/week product developers work on their assignments. In most companies I work with, engineers and managers rarely work 40 hours or less per week. It is not unusual for new product developers to work 9- to 10- hour days as they attempt to beat the time-to-market clock. For the most part, Silicon Valley engineers regularly work a 45-to 50-hour week. Some engineers work a little more and some a little less. For discussion purposes, let's say the average is on the high side of the range at 50 hours per week. This becomes the reference work level.

In my aerospace days, I learned where the limits of endurance were set for most engineers and their managers. Events in Vietnam or in Russia had a major impact on our product development strategy, logistics, and tactics. The stakes were high. To respond, we routinely worked 12-hour days and Saturdays. In one stretch, we went on this way for 1.5 years. On a weekly basis, working 12 hours per day 6 days per week works out to 72 hours/week. We did good things, spirits were high, few mistakes were made, and we retained the ability to think in rational terms. Sometimes we worked a 14-hour day and a Sunday but knew work commitments at this level were not sustainable. Working a 72-hour week is sustainable—you can give of yourself at this weekly rate for a long, long, time. The question that needs to be answered is: Do you want to do this?

For most of us, the answer is "no" and we'll find ways to throttle back to the 40- to 50-hour range. After nearly missing the births of my two daughters and taking part in only a fraction of their lives in the early years, I decided change was in order and made a move to the commercial side. But with me came the experience of working at close to the limit for a good number of years.

Here's a way to use the information I just described. First, determine the average hours the new product development team is working. Compare that number to a 40-hour per week reference figure. Determine the value of the "adjusted" commitment based on this information. For example, it is found that a product development team is pushing close to the limit of endurance at 65 hours per week, or 15 hours per week above the norm of 50 hours. As such, the adjusted commitment is 1.30.

With the adjusted figure known, the engineers and managers in this environment then have to ask a few critical questions—with the most important being—is it worth it? A "no" answer means that the scope of the job needs to be reduced by 30% or staff must be increased by 30% to meet time-to-market goals. Or going down 15% on work content and up 15% staffing gets the product to market at the same time.

The main message here is to determine the adjusted commitment on all your new product development programs. Then use it to make adjustments to meet time-to-market goals and simultaneously improve the quality of life outside the work environment. The closer commitment gets to a value of 1.0, the better it gets on and off the job—it's a business and personal win-win.

More information on this topic is contained in New Product Development: Design and Analysis, which can be obtained by calling Time to Market Associates.

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CIRCLE 200 FOR U.S. RESPONSE   CIRCLE 201 FOR RESPONSE OUTSIDE THE U.S.

QUICKLOOK

QUICK NEWS: CONFERENCES & SEMINARS

On-demand printing entails storing documents electronically and printing only what is needed at high speed and in any volume. The University of Wisconsin-Madison's Department of Engineering Professional Development is offering the course "Cost-Effective Publishing: Electronic On-Demand Print" in Madison, March 24-25, 1994. For a complete program, dial the department's 24-hour fax line at (608) 265-2105; request information on program 4231. Mailing address is Department of Engineering Professional Development, University of Wisconsin-Madison, 432 North Lake St., Madison, WI 53706. CIRCLE 465

Users and implementors who are interested in the Integrated Services Digital Network (ISDN), which uses telephone lines to transmit voice, graphics, and computer data simultaneously are welcome to attend the 1994 meetings of the North American ISDN Users' Forum.

The first meeting of the users forum is scheduled to be held from February 8–11, 1994 at the Hyatt Regency Tech Center in Denver, Colorado. For further information on the meeting, contact Dawn Hoffman, B364 Materials Building, NIST, Gaithersburg, MD 20899-0001; (301) 975-2937; fax (301) 926-9675. CIRCLE 466

TALES FROM A SKUNK WORKS

My past two columns have discussed scorekeeping in the era of global head-to-head competition. I contend that market share is a better indicator of a company's success than stock price and that punishing failure destroys the environment of innovation and skunk works.

Skunk works help business success, but it is important to place this in context. Wall Street doesn't much care why products succeed, and this is one reason that there is little demand for candid business history. Two recent examples may illustrate this.

A wealthy friend of mine bought some stock. I was watching two of the companies professionally, since they represented possible clients. I knew that both firms had serious problems on the near horizon. Since I was not under nondisclosure, I warned my friend. He was unperturbed. When I saw him, months later, the problems had surfaced and the stocks were greatly depressed.

Concerned and curious, I asked, "How did your investments turn out?" "Oh," he said, "I made some money and sold." I was amazed, "Why did they go up?" He shrugged, "Some analysts said they would."

In another case, a former boss was CEO of a large but declining firm. Several times we discussed retaining The Trudel Group as consultants to help turn the company around, but investment in new products and businesses would lower earnings and the stock price. For years, his company downsized. Finally, it was sold and he retired. Through it all his board of directors and company stockholders were satisfied. Presumably, had he lowered profits and taken some risk by investing for growth, they might have replaced him.

To engineers this seems illogical, but this is how too many U. S. companies now operate. I discussed some of these things in the chapter titled "Why we fail" in my book.

Like the Japanese, I believe that success ultimately depends on building unique products that people want to buy. I advocate skunk works because they can increase product success rates if: 1) products are knowledge-based, and 2) markets and technologies are uncertain or rapidly changing.

This too needs context: Most innovative new products fail. Well-documented studies in the consumer sector point to failure rates of 90%. High-tech products have records that are even worse.

It doesn't take a rocket scientist to realize that if you start with a success rate of only 10%, even dramatic improvements will have a majority of failures. The Japanese accept this—their new product "failure" rate is much higher than ours. The trick is to use failure as an investment in knowledge and make the second or third product a winner. Three is a good number. Consider the 386 or Windows 3.0, and their relatively puny predecessors.

A successful skunk works requires an environment that cherishes new products and can tolerate failure. My next column will talk about how to get started.

John D. Trudel lectures and provides business development consulting. Trudel is founder and director of The Trudel Group, 52001 Columbia River Hwy., Scappoose, OR 97056; (503) 640-5599; fax (503) 543-6361; e-mail address: JohnTrudel@aol.com. He is the author of High Tech with Low Risk. *To order, phone (503) 280-8547.*

HOT PC PRODUCTS

PackRat 5.0, a Windows information manager, enables users to organize their Windows desktop. The software has a SmartStart feature, which automatically designs a start set of folder workspaces configured according to the user's profession. Users may design as many folders as needed and label them by name and color for easy retrieval.

By assigning the software's Action Buttons to complex tasks such as setting up letters and faxes, users can streamline these jobs to a click of the mouse. Data entry can be personalized with custom form fields, which may be designed to reflect the information required. By placing Application Icons on folders, users can create groups of applications to complete tasks; version 5.0 is fully integrated with Microsoft Word for Windows, WordPerfect for Windows, Lotus Ami Pro, Microsoft Excel, Eclipse Fax, Delrina WinFax Pro, DaVinci, Microsoft Mail, cc:Mail, CompuServe, Sharp Wizard, and others. The software has a list price of $395. A three-user network version goes for $695. Contact Polaris Software Inc., 17150 Via Del Campo, Suite 307, San Diego, CA 92127; (619) 674-6500; -7316. CIRCLE 467

A low-cost version of the EPLD Development System (XEPLD) for designing with Xilinx erasable programmable logic devices (EPLDs) is now available for personal computers. XEPLD version 4.1 is a full-featured toolset that includes an automatic design fitter, optimizer, and design-report generator, all of which support the company's entire family of EPLD devices. The software works seamlessly with industry-standard PAL logic compilers, and languages such as ABEL, CUPL, and Palasm. Optional schematic simulation libraries are available for use with Mentor Graphics, OrCAD, and Viewlogic systems. XEPLD version 4.1 costs $89.95. Contact Xilinx Inc., 2100 Logic Dr., San Jose, CA 95124; (408) 559-7778. CIRCLE 468

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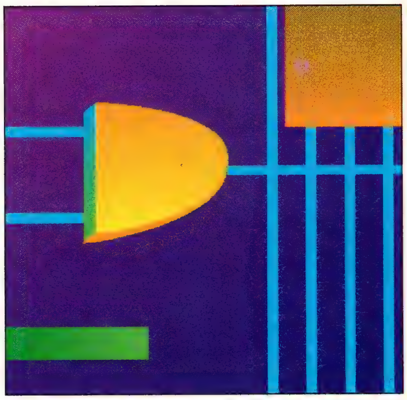

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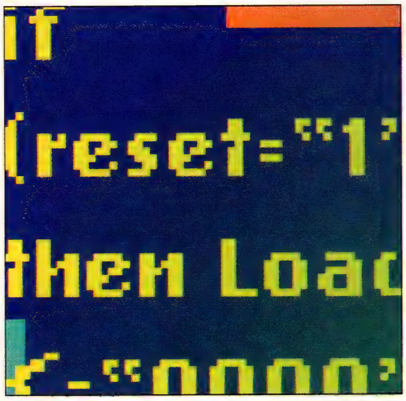

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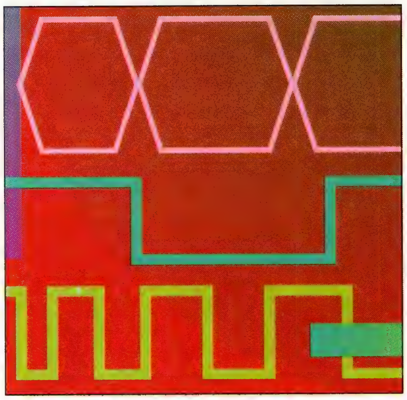

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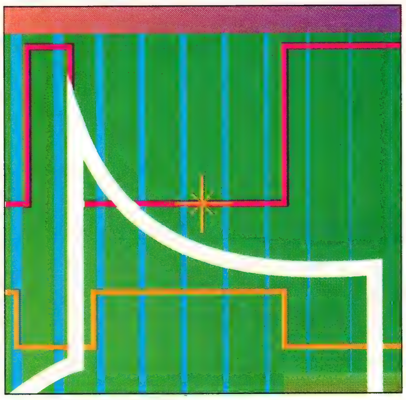

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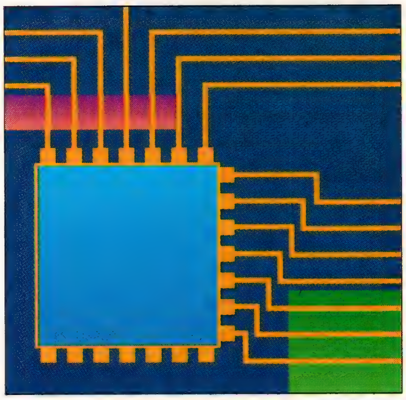

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CIRCLE 521

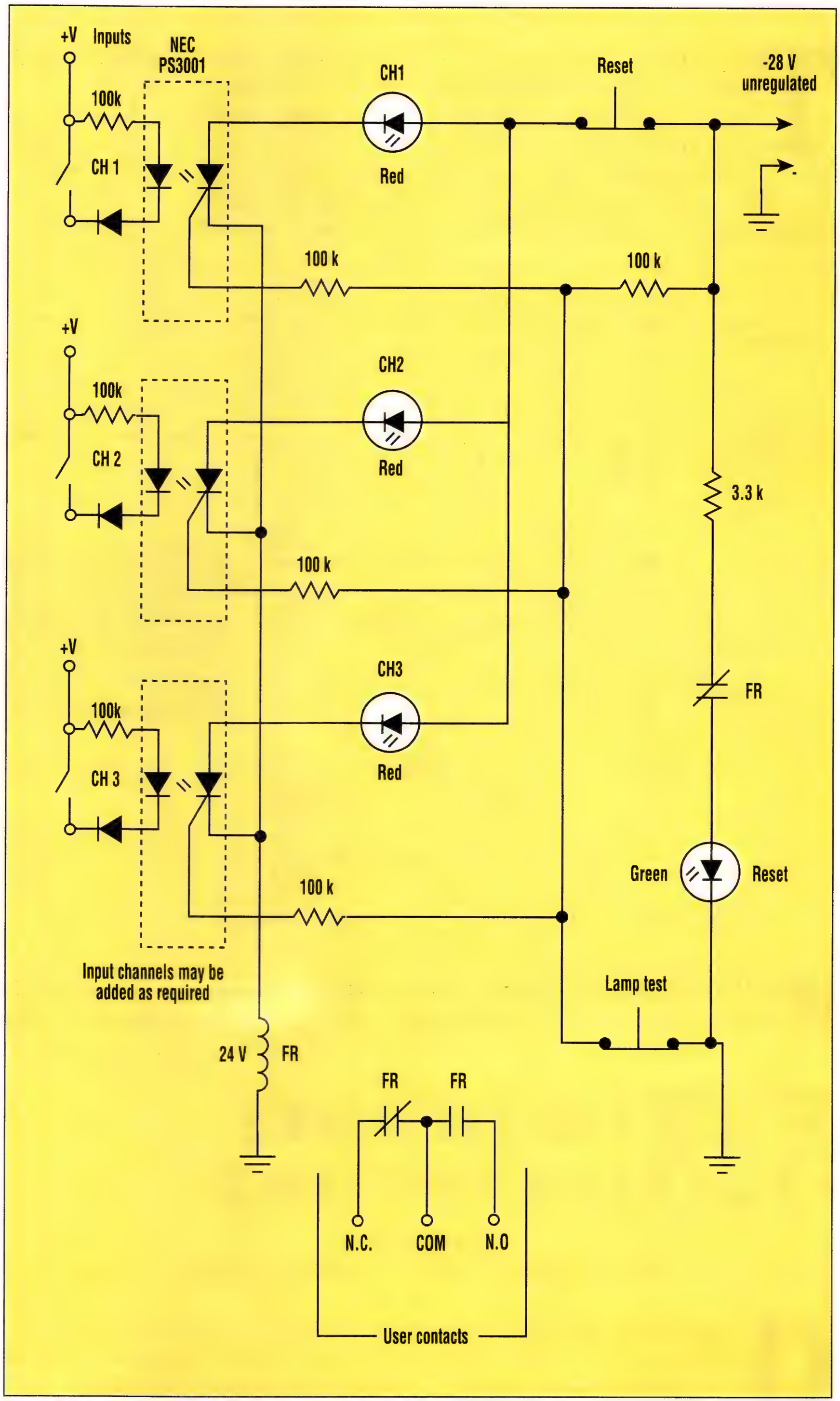
SCR-OPTOCOUPLER FIRST-OUT DETECTOR

CRAIG MERZ
ITT Manufacturing, P.O. Box 15, Califon, NJ 07830; (908) 832-6605.

When a piece of equipment experiences a shutdown, a "first-fault" or "first-out" detector can be used to determine which part of the circuit initiated the problem. The detector circuit also can be used in a game to display the first respondent and lock out all others. The circuit uses an SCR-type optocoupler to perform both the display and lockout functions *(see the figure)*.

The circuit operates as follows: Assume a monitored contact across the channel 2 input opens. This turns on channel 2's optocoupler SCR, lighting the red channel-2 LED, energizing the FR relay coil, and turning off the green "reset" LED. Due to the properties of a SCR, the circuit will remain in this condition until power is momentarily removed by pressing the "reset" pushbutton. The channel 1 and 3 optocoupler SCRs now have so little voltage applied across them that any input will not be able to turn them on, effectively "locking out" channels 1 and 3. Pressing "lamp test" turns on all optocoupler SCRs simultaneously. The "FR" user contacts may be employed to sound an alarm or initiate any other appropriate action. Because all inputs are isolated, different circuits may be monitored.

The circuit inputs shown will work on 90 to 250 V ac or dc (+ voltage applied to the resistor). Other input voltages may be accommodated by properly scaling the optocoupler LED resistor. The resistor must be high enough so as not to cause significant loading of the circuit being monitored. Any number of input channels may be added as required. With the circuit in the "reset" condition, all SCRs have the full 28 V dc applied across them. An assembled circuit board or parts kit for a 10-input unit is available for evaluation.☐



A "FIRST OUT" DETECTOR, useful in determining the circuit that initiates equipment shutdown, can be created with this design that makes use of an SCR-type optocoupler. It can perform both the display and lockout functions of these detectors.

IFD WINNER

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David Laude, 7040 Franciville Rd., Colorado Springs, CO 80908. His idea: *"Switching Boost Regulator Uses 555."*

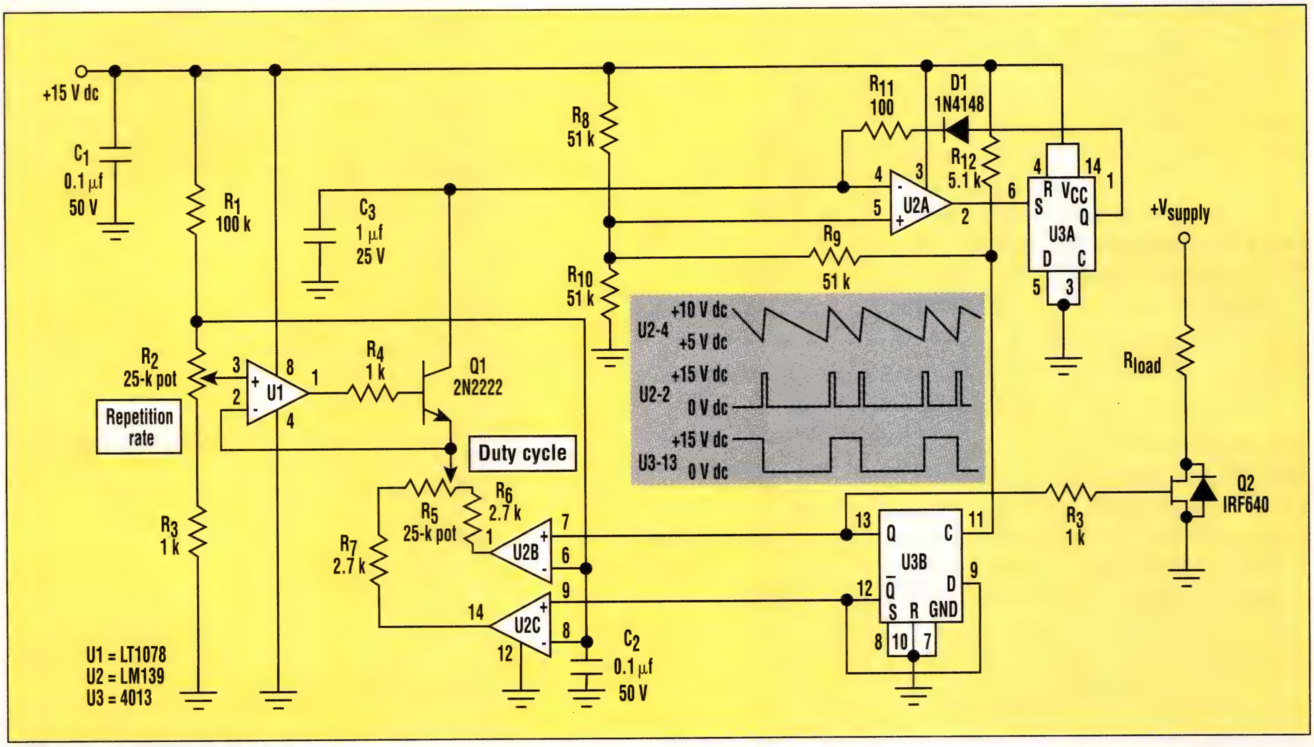
CIRCLE 522

Vary Rep Rate, Duty Cycle Separately

GEORGE ALTEMOSE
Pall Instrumentation Technology, 225 Marcus Blvd., Hauppauge, NY 11788; (516) 273-0911.

This variable frequency oscillator provides a squarewave output, and allows repetition rate and duty cycle to be adjusted independently *(see the figure)*. Duty cycle remains constant as repetition rate is adjusted; conversely, repetition rate remains constant when duty cycle is varied.

The basic oscillator function is supplied by comparator U2A, which toggles flip-flop U3B. The complementary flip-flop outputs alternately enable comparators U2B and U2C, which control the constant-current discharge of C_3. Repetition-rate adjustment pot R_2 sets the reference voltage for op amp U1. The capacitor discharge current is therefore equal to this reference voltage divided by the selected resistance from Q1's emitter to ground. It's important for U1 to employ a pnp input stage, allowing the input voltage range to extend to ground. "Extra" flip-flop U3A acts as a buffer to provide a high-speed charge path for C_3. Power FET Q2 is a high-voltage (200 V), high-current (18 A) device for driving solenoids or similar large loads.☐



REPETITION RATE and duty cycle can be adjusted independently with this variable frequency oscillator. As duty cycle is varied, repetition rate remains constant, and if repetition rate is adjusted, duty cycle remains constant. The inset waveforms show circuit operation.

CIRCLE 523

Circuit Mimics Low Resistance

YONGPING XIA
EBT Inc., 2522 W. 237th St., Torrance, CA 90505.

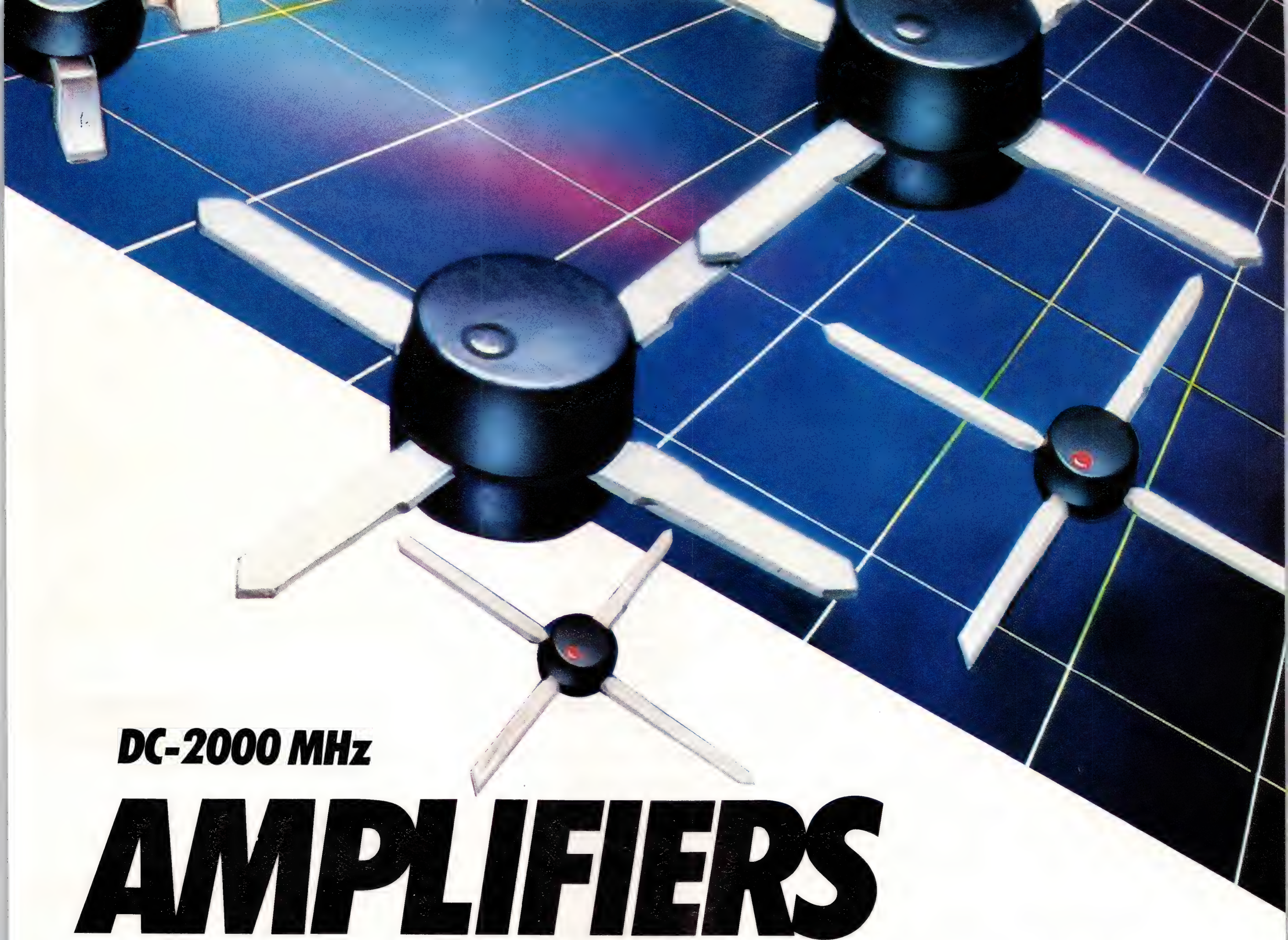
Occasionally, an application will require a high-power low resistance as a dummy load. One way to create such a circuit is by using a MOSFET to mimic an adjustable low resistor that's controlled by a normal potentiometer *(Fig. 1)*. Moreover, this circuit doesn't need to share the ground with the measured circuit as a load due to the way it's powered.

A bridge is formed by R_4, R_5, R_6, and the internal resistance (R_{in}) of a logic-level MOSFET (Q1). If the

TABLE 1: MIMIC RESISTANCE LINEARITY

Voltage (V)	Current (A)	R_{in} (Ω)
2.50	0.258	9.69
3.00	0.309	9.71
4.00	0.412	9.71
5.00	0.516	9.69
6.00	0.620	9.68
7.00	0.723	9.68
8.00	0.828	9.66
9.00	0.931	9.67
10.0	1.035	9.66
12.0	1.243	9.65
14.0	1.453	9.64
16.0	1.660	9.64

$R_4 = 0.1$; $R_5 = 10$ k; $R_6 = 100$



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CERAMIC SURFACE-MOUNT	RAM-1 4.95	RAM-2 4.95	RAM-3 4.95	RAM-4 4.95	RAM-6 4.95	RAM-7 4.95	RAM-8 4.95	
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Freq.MHz,DC to	1000	2000	2000	1000	2000	2000	1000	1000
Gain, dB at 100MHz	18.5	12.5	12.5	8.3	20	13.5	32.5	12.7
Output Pwr. +dBm	1.5	4.5	10.0	12.5	2.0	5.5	12.5	17.5
NF, dB	5.5	6.5	6.0	6.5	3.0	5.0	3.3	3.6

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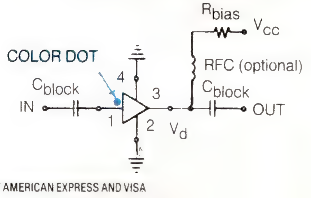
80 x 50	1000, 2200, 4700, 6800, 10,000 pf
120 x 60	.022, .047, .068, .1μf

Typical Circuit Arrangement



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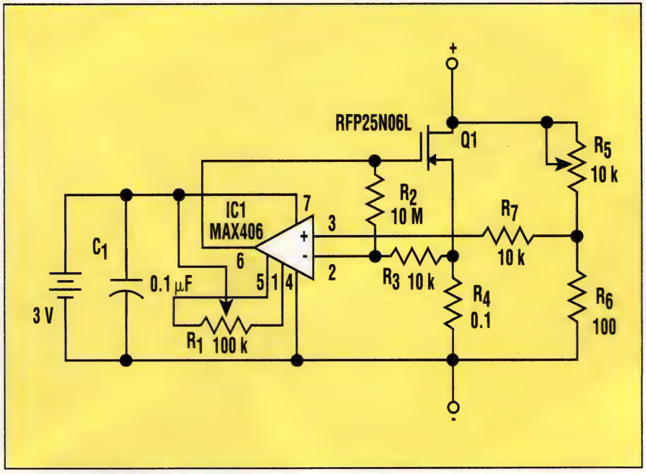

TO MIMIC low resistance, this circuit employs a MOSFET that mimics an adjustable low resistor controlled by a normal potentiometer.

bridge is balanced, $R_{in}/R_4 = R_5/R_6$. The circuit's total resistance is $R = R_4 + R_{in} = R_4(1 + R_5/R_6)$. If $R_5 >> R_6$, $R = R_4 \times R_5/R_6$. An op amp (IC1) amplifies the error of the bridge to adjust the voltage on Q1's gate. The amplifier's gain is determined by the ratio of R_2/R_3, which is 1000 in this case. Consequently, the bridge will be self-balanced. It's important to trim IC1's input offset voltage to eliminate additional error. R_1 can be adjusted to set IC1's output to half of the power supply (in this case, it's 1.5 V).

IC1 is powered by a lithium battery. Because the circuit only consumes about 1-µA, a 100-mAh battery can last at least ten years. Therefore, a switch that turns off the battery is unnecessary. With a proper heat sink on Q1, the circuit can handle up to 75-W power consumption.

Table 1 shows the linearity of the mimic resistance under different voltage. Table 2 gives the relationship between variable resistance R_5 and mimic resistance.☐

TABLE 2: R5/MIMIC RESISTANCE RELATIONSHIP

R_5 (k)	Current (A)	R_{in} (Ω)	R_5(k)/R_{in}
5.00	1.026	4.87	1.03
6.00	0.857	5.83	1.03
7.00	0.735	6.80	1.03
8.00	0.645	7.75	1.03
9.00	0.573	8.73	1.03
10.0	0.516	9.69	1,03
12.0	0.432	11.6	1.03
14.0	0.370	13.5	1.04
16.0	0.323	15.5	1.03
18.0	0.287	17.4	1.03
20.0	0.259	19.3	1.04
25.0	0.208	24.0	1.04
30.0	0.173	28.9	1.04
35.0	0.148	33.8	1.04
40.0	0.130	38.5	1.04
45.0	0.115	43.5	1.03
50.0	0.104	48.1	1.04

$R_4 = 0.1$; $R_6 = 100$; $V = 5.00$

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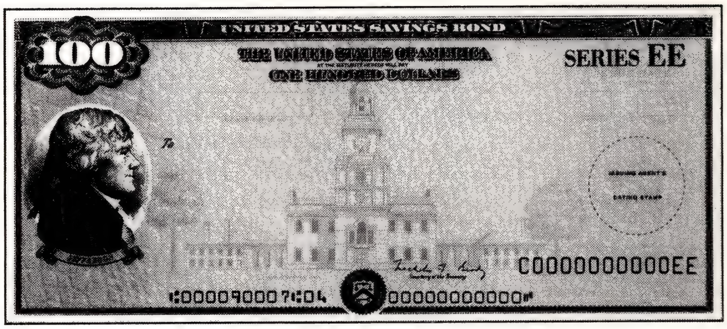

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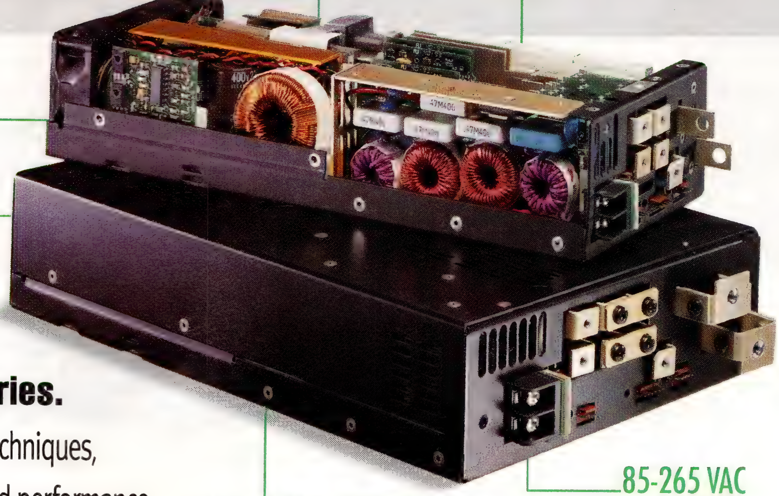

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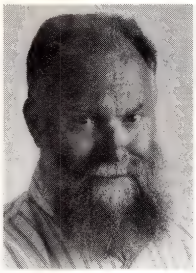

BOB'S MAILBOX

Dear Mr. Pease

I am one of the young promoters of Fuzzy Logic, or "F.L. Guys" you spoke about in your "What's All This Fuzzy Logic Stuff, Anyhow? (Part II and III)." But you may find it somewhat surprising that I agree with much of what you said. There are far too many people out there making exaggerated claims about how F.L. can be applied and what benefits should be expected. It is truly unfortunate that the hyping of F.L. as a panacea has obscured the fact that, properly applied, F.L. can provide real benefits.

Many of the people who have given F.L. a bad name are the academic types who, as you stated, speak as if they are "preaching to the converted." I am as tired of hearing about how F.L. will give you "more robust control" as you are about hearing about probability. Working for a factory automation company, I do not have the luxury of strictly dealing with theory (like the academics); I have to provide tangible benefits.

Omron has been a leader in the development of F.L. in various forms—microcontrollers, software and development tools, controllers, and turnkey systems. In the U.S., our focus has been on automation products. We are not actively marketing chips and software at this time.

It's important to note that in the introductory stages of anything new, it's easy to get carried away with the potential impact. (America's space program serves as an example. Weren't we supposed to have colonized Mars by now?) The promise of F.L. was no different. Today, though, as suppliers and supporters become more familiar with F.L., we've also become more aware of its practical applications and implications. Much of the boasting has ceased, though not totally disappeared.

At Omron, we've never made a blanket statement that F.L. is superior to conventional systems. The fact that our single-loop controllers (the ready-to-use 1/4 and 1/8 DIN types, not microcontrollers) use a hybrid of PID and F.L. processing speaks to this point. PID control alone is a perfectly acceptable control method in about 80% of the process applications we see. However, the other 20% are critical applications that are susceptible to process upsets, where the PID parameters cannot be tuned to provide the desired combination of responsiveness and stability. With our controllers, the PID constants can be tuned for stability, while the F.L. part of the algorithm deals with responding to the disturbance.

Our customers using this particular controller report significant improvement of process control using the F.L.-based product over the PID product (also Omron's). These customers are in the food, pulp and paper, pharmaceutical, medical products, semiconductor, and other industries. When one of these customers allows us to write about the application, we'll be sure to send you the details. Until then, we accept customer orders for more F.L.-based controllers as proof that they work better for them in their applications.

Omron's tests of performance in controlled environments yielded a 50% improvement in controller response time over PID-only controllers. We fully understand, though, that this improvement in response time is important for only some of our customers. But, for those customers, the only really important thing is that the F.L. product solved their problem.

Like you, Omron also disagrees with the idea that F.L. users don't need models to develop a system. Our seminars on F.L. emphasize the need for a thorough understanding of the system to be controlled, and a clear understanding of the overall objectives of the project before F.L. can be successfully applied. Our stance is if a conventional controller can provide the necessary performance, USE IT! If not, a F.L.-based product may solve the problem.

As with virtually everything else in life, it comes down to a cost-benefit compromise. You mentioned in your column that a PID algorithm could be written to accomplish the same performance as the F.L. solution; all that's needed is a faster computer. The question then is how fast? And is this faster computer available at a cost and engineering development level that's acceptable to the customer?

Thanks for helping to bring the benefits of Fuzzy Logic into focus. It is not a panacea as some zealots might claim, nor is it a boondoggle of unfulfilled promises. Fuzzy Logic is simply another tool in the engineer's toolbox—an alternate control processing technique for use alone or in combination with other techniques for applications that have resisted other methods, or that require F.L.'s innate ability to capture the intuition and judgment of a skilled expert.

ROBERT NEAGLE
Product Marketing Specialist
Omron Electronics Inc.
Schaumberg, Ill.

Thank you for the Sanity Check. When you and I are able to provide more details of where F.L. can provide real benefits, we'll speak up. However, some experts tell me that F.L. needs less computing power to do a job (vs. conventional controllers). And other experts say that in many cases, F.L. needs more computing power. Nothing simple in the whole world!—RAP

Dear Mr. Pease:

While reading your recent "What's All This Fuzzy Logic Stuff, Anyhow? (Part II)" column, I was reminded of a past experience that may pertain somewhat to the state of the Fuzzy Logic community. Some years ago, at a different firm, we hired a software engineer, Bob. In a strange sort of way, Bob was very bright. He was to a great extent self-educated. While that is not a bad thing, Bob's knowledge ended up having unexpected gaps, which, unfortunately, he had little interest in filling. Being clever, he had developed many interesting techniques to deal with design problems over the years. He was very proud of these, and considered them to be original and unique. But, unknown to Bob, many of them were simply traditional designs that Bob had rediscovered.

I remember one case in which he proudly described how he would make his software "anticipate" the arrival of a certain external event that occurred at fairly uniform, although not exactly known, time intervals. He began a long discussion explaining how this miracle worked, using a combination of the system's local timebase and some of his software. Part way through, I interrupted him, and tried to tell him that the thing he was describing had a name. It was called a phase-locked loop. Bob countered that I couldn't have understood him correctly. *He* had invented this thing two years ago, and *he* had not named it a PLL.

I explained that I understood correctly, and although his terms were unconventional, he was indeed describing a PLL. PLLs were not invented two years ago, but have been used for about half a century. I explained that although the original ones were analog circuits, purely digital ones also existed. Using a fixed clock and a variable modulus counter (rather than an analog VCO), they were very common in systems that recovered synchronous serial data, and could be found in various popular datacom peripheral chips.

I explained that Bob's code was simply a software implementation of one of these digital PLLs. These software implementations were not unusual, being found in some automobile-engine timing-control software, among other places. Of course, Bob had never seen anyone else's digital PLL, although he had used products full of them. I suspect he may even have seen an analog one, but never made the connection between that circuit and his "invention."

Bob was very resistant to my claim that textbooks contained well-documented analysis techniques for his invention, since he, the inventor, had to tune his creation by trial and error. But I don't think he ever had the slightest interest in looking through such texts. He didn't accept that we already understood his invention in detail, or that we already had enough experience with PLLs to know that it was not the best answer to the current problem.

Bob deserves a lot of credit for having independently reinvented something as wonderful as a PLL. But, because of his limited background, he failed to understand that what he had created was not all that impressive, and was very unreceptive to having this pointed out to him.

I suspect that some F.L. proponents may have similarly weak backgrounds, and may not have seen examples of *well-designed* traditional control systems. Bob's PLL implementation was not immediately recognizable as a PLL, even though in the end it proved to be a classical device. I further suspect that some of the things we see in Fuzzy systems are, in fact, techniques that have been in use for some time to enhance traditional controllers, but mapped into a different domain where they are no longer recognizable.

I don't mean to imply that F.L. has not embodied classical control equations. I am referring to the clamps, limiters, nonlinear signal conditioners, "anti-windup" circuits, hysteresis, feedforward, etc., which are often part of real (if not textbook) controllers. Some of these features long predate software, being found in analog and even some ancient pneumatic/mechanical controllers.

An advantage of F.L. may be that it can produce a very good controller by following some analytical design procedure. However, the enhancements added to traditional controllers to improve their performance were generally the result of the skill and experience of the engineer.

There have always been physical systems that traditional control textbooks regard as more or less uncontrollable, or at least very difficult to control. When such systems are easily brought under control by F.L. techniques (and some have been), we have an accomplishment worthy of respect. But, most of the commercial products claiming to use F.L. today do not seem to fall into this classification. Therefore, I find myself in agreement that F.L. is not quite as revolutionary as its proponents claim.

ERIC KINAST
Engineering Manager
Sonntek Inc.
Woodcliff Lake, N.J.

*Every engineer must be prepared to invent a circuit or function that he/she has never seen before. If it then turns out, it's already been done before, there's no point in getting mad! As I mentioned in my 1992 columns (*ELECTRONIC DESIGN*, Jan. 9, p.41 and Nov. 12, p.80) the PLL was developed as early as 1783, for adjusting clocks and watches. Fuzzy Logic may be a useful tool to help us handle nonlinearity. But it doesn't usually give ideal results just by pushing a button—the engineer still has to provide skill, experience, and thinking.—RAP*

Dear Bob:

In your femtoamp column in the Sept. 2 issue, you mentioned placing guard rings on the bottom and possibly the top of the pc board to stop stray leakage currents from reaching sensitive nodes. While working at a company here in Cleveland that makes femtoamp meters, I also learned to "stitch" the pc board. In other words, to put numerous plated through-holes between the top and bottom guard rings. We found conduction down some of the fibers under the surface, so we added the holes to break these conduction paths. I don't know if this was just a process problem making pc boards 15 years ago, or if it still exists. But I still stitch boards around sensitive nodes.

GARY BERGSTROM
Bergstrom Consulting
Chagrin Falls, Ohio

I've stitched my pc boards for different reasons, but you are right in this case. Thanks.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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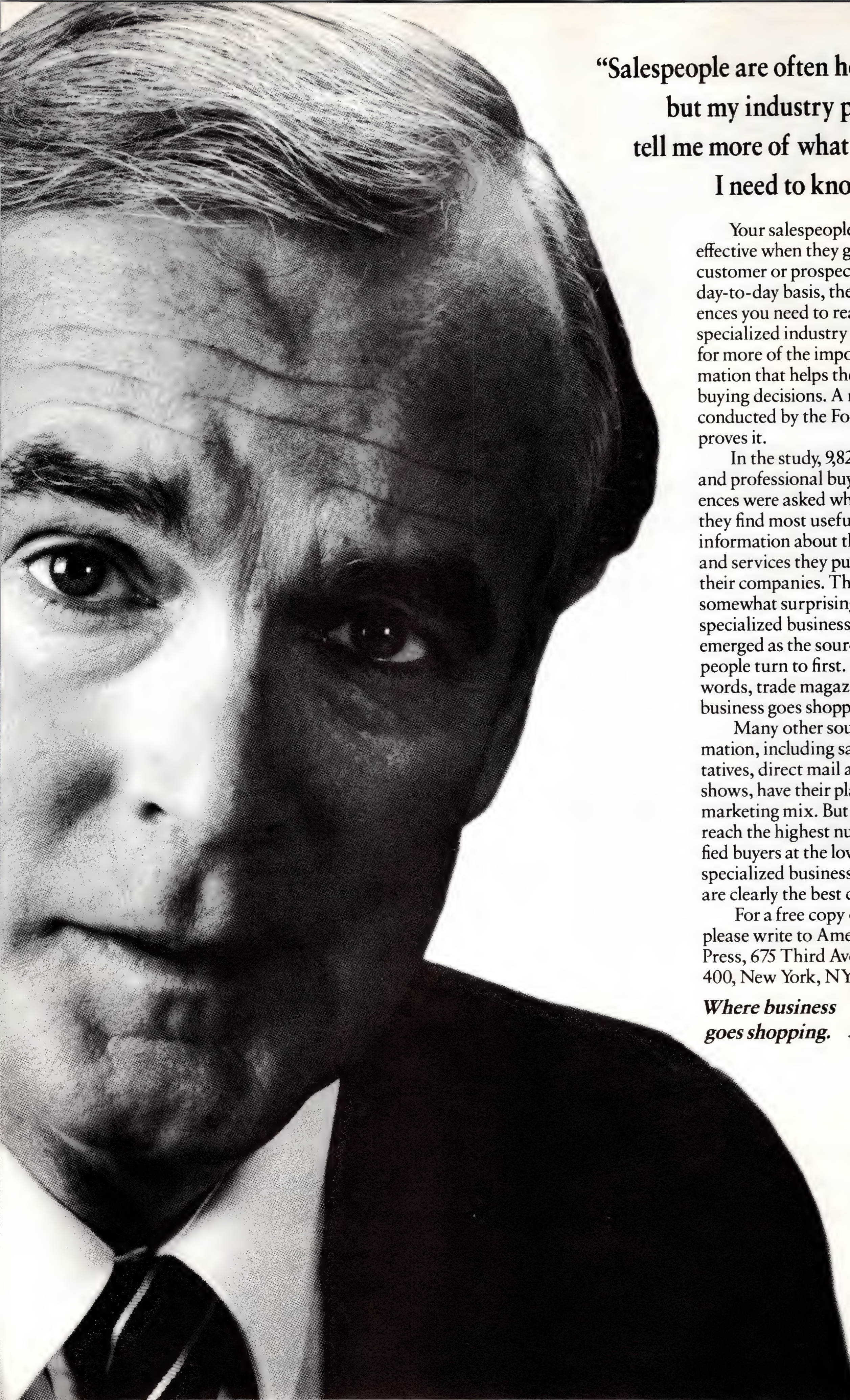

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ELECTRONIC DESIGN

Take Heed When Powering Portables

Hidden pitfalls await the digitally-oriented designer. Skirt them by understanding their analog roots.

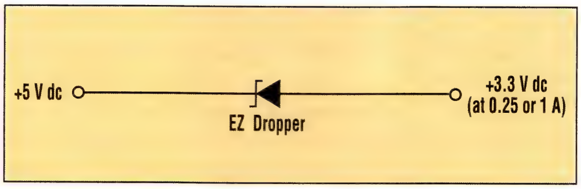
BY ART FURY

Semtech Corp., 652 Mitchell Rd., Newbury Park, CA 91320; (805) 498-2111, ext. 230.

Minimizing power consumption in portable equipment, particularly PCs, has been and continues to be a critical design issue. However, emerging new power-supply topologies (the circuitry that converts one voltage to another) and the growing array of low-power ICs (2.0 to 3.8 V) are ushering new design issues into the limelight. What that means is power consumption now must be considered alongside the issue of how best to control and/or convert power to assure trouble-free operation with extended battery life.

Designers undoubtedly will flock to lower-voltage ICs for their lower power consumption. But it's likely that their designs will comprise a mix of ICs that operate at varying voltage levels. Voltages may range from 5 V down to the 2.0-to-3.8-V range. Although JEDEC has tried to establish 3.3 V as a new standard, we're seeing many "quasi-JEDEC" low-voltage ICs that operate at other levels. This trend continues unabated, which means designers must optimally power a mix of chips at different voltage levels within shrinking portable equipment.

Solving this power puzzle seems to be a straightforward task, but there are perilous pitfalls with analog roots that may elude the digitally oriented designer. Even when the data sheet for a given power-supply topology looks like a good fit, disastrous consequences may only arise during actual use.



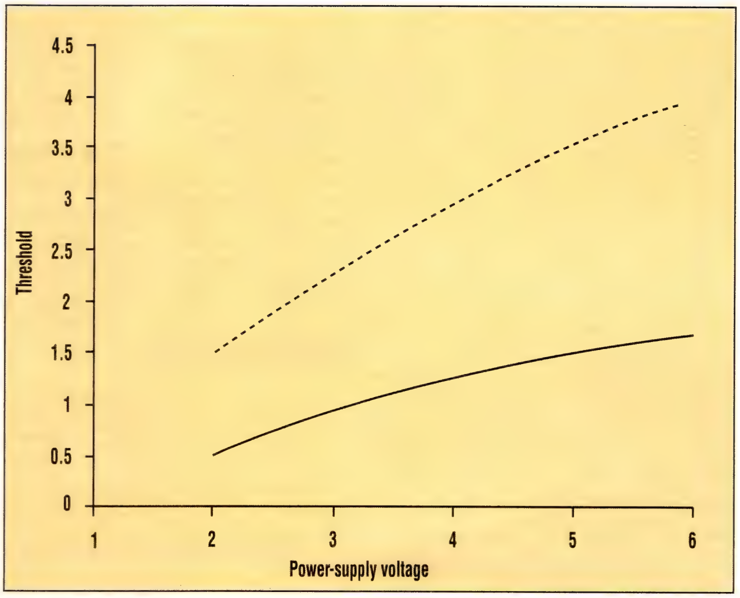
1. One linear-topology option, the unregulated EZ Dropper, is a simple Zener topology. It subtracts 1.70 V from the 5-V input to derive the 3.3-V output over a wide range of current.

The same ICs that promise less power drain may also reduce noise margins, thereby increasing vulnerability to glitches caused by noise. The means of powering low-voltage chips can also subtly affect battery life—but not always positively.

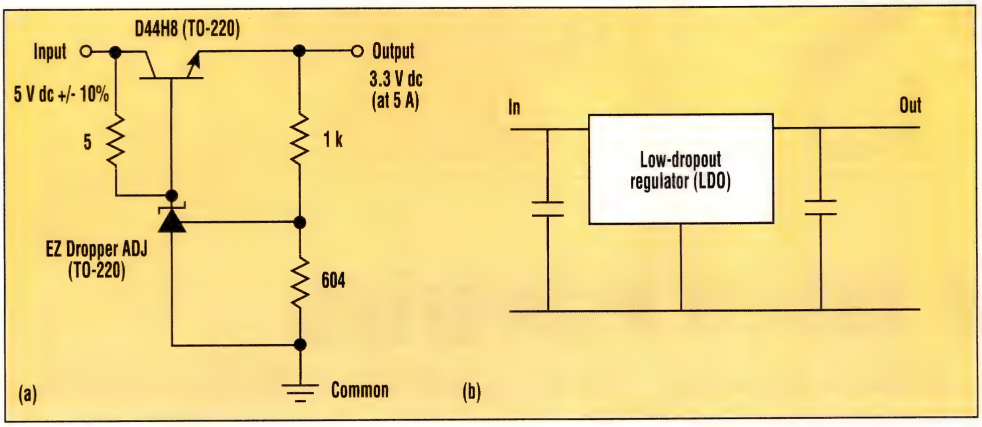
The means by which power is controlled and/or distributed in portable equipment is just as critical as power consumption. To help the digitally-oriented designer of portables cope, let's examine some of the more critical traps lurking within power-supply topologies.

Topology decisions are often made without investigating in-situ system performance. Historically, cost has driven topology selection. In the past, typical ac power supplies were made bulky by a transformer that dropped 110 V (50/60 Hz) to lower voltages for bridge rectification and then regulation.

As switching supplies emerged and frequencies increased, much smaller transformers came into vogue. More-



2. Shifting logic thresholds are a hidden pitfall when powering a mix of ICs that operate at different voltage levels within the same system. In worst-case shifts, the margin between a logical one and a logical zero narrows.



3. Because microprocessor speed depends on supply voltage, a well-regulated supply is needed. In the case of both the regulated EZ Dropper (a) and the low-dropout regulator (b), significant output current results in wasted power. Both offer highly regulated output voltages, and the low-dropout regulator also provides current limiting and thermal shutdown.

over, by varying the duty cycle (the ratio of time on to time off), the output voltage could be regulated, eliminating the need for a linear regulator and its resultant heat (E × I losses). This switched-mode power-supply (SMPS) topology has eclipsed linear topologies on many fronts by providing significantly greater efficiency as well as size and weight cuts of about 80%.

Early in its history, the SMPS topology introduced glitch-causing gremlins that were generated by switching input voltages at high frequency. These gremlins, which took shape as large spikes and EMI, were eventually contained by shielding and filtering.

While SMPS is widely accepted, it's not necessarily better than linear topologies, particularly when it comes to powering a mix of ICs operating at differing voltage levels. The most important distinctions between typical linear and switcher topologies are efficiency and cost. Simply stated, at low power, switchers are highly efficient and costly, whereas linears are inefficient and inexpensive.

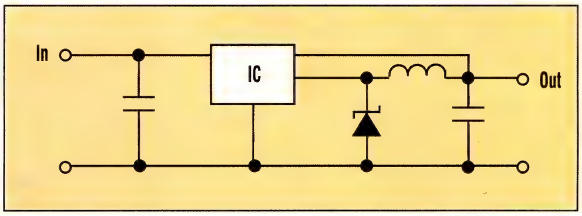
For a linear topology, efficiency can be approximated by simply dividing the output voltage by the input voltage. So, for a 3.3-V output derived from a 5-V input, efficiency is 66%. By contrast, a switcher topology with the same input-to-output ratio yields an efficiency that can range from 80% to more than 90%. But the switcher's higher efficiency doesn't come without a price: It can cost ten times more than a typical linear.

Let's now explore the efficiency-vs.-cost trade-offs when powering a circuit board populated with a mix of today's ICs. Consider a circuit board that's designed with 5-V ICs. You want to add a new low-power IC that operates at 3.3 V. The small amount of current drawn by the 3.3-V IC argues against using a switcher. The high cost of implementing a switcher topology doesn't warrant the minor boost in efficiency. Moreover, the switcher could radiate EMI that might adversely affect the portable system's operation. In this case, a simple on-board linear topology that converts the supply's 5 V to 3.3 V for the low-power IC is the best answer.

Although a linear topology could simply use a resistor to drop an input voltage to supply the desired output, the drop across the resistor (and hence the load) is proportional to the current. And rare is the load that draws a constant current. The EZ Dropper linear topology developed by Semtech Corp., Newbury Park, Calif., assures a constant voltage drop in series with the load. This simple Zener-like topology subtracts 1.70 V from the 5-V input to derive the 3.3-V output over a wide range of current *(Fig. 1)*. But it does so without regulation, which means the output will directly track the input. This may or may not be desirable, depending on the application. For example, a ±5% variation on the input (±0.25 V) makes it impossible to limit output-voltage variation to ±0.1 V (i.e. 5.25 V – 1.70 V = 3.55 V, then 3.55 V – 3.30 V = 0.25 V). At first glance, this drawback could prompt a search for alternatives to the simple Zener topology. But when considering its benefit of noise rejection, one must examine the need for noise margin versus regulation.

Most 3.3-V ICs are designed to operate over a wide range of power-supply voltages, and the logic thresholds, or the voltage levels that determine ones and zeros, vary with supply voltage *(Fig. 2)*. Note that the margin between a logical 1 and logical 0 decreases significantly if the supplies are at their opposite limits of 4.75 V (minimum for 5-V supply) and 3.4 V (maximum for 3.3-V supply). It's even worse with a 5-V, 10% supply. Accordingly, the Zener topology's characteristic of the output tracking the input is desirable because it reduces noise margins to a lesser extent.

Because microprocessor speed depends on supply voltage, a well-regulated supply is needed. Let's examine two linear topologies that incorporate regulation *(Figs. 3a and 3b)*. In both cases, significant output current results in wasted power. Output voltage for both topologies is highly regulated, and in the case of the low-dropout regulator (LDO), there's also current limiting and thermal shutdown. If the input voltage is more than 2 V higher than the desired output voltage, a conventional regulator like the common 7800 Series regulator is a good choice. In the case of dropping 5 V to 3.3 V, insufficient headroom dictates using one of the topologies shown in



4. The buck regulator is the lowest-cost switcher because of its lower component count and simple magnetics. But because there's no isolation between the input and output, it's possible for the input voltage to be applied to the output if the device fails.

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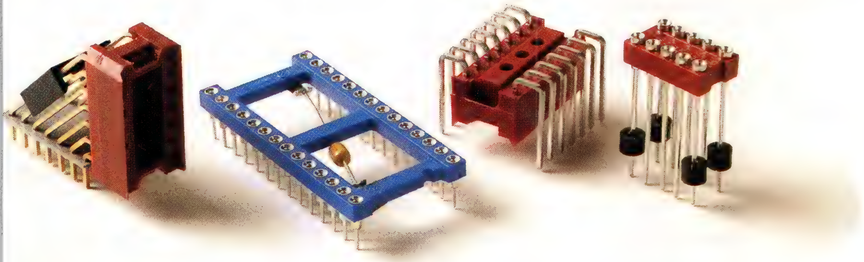

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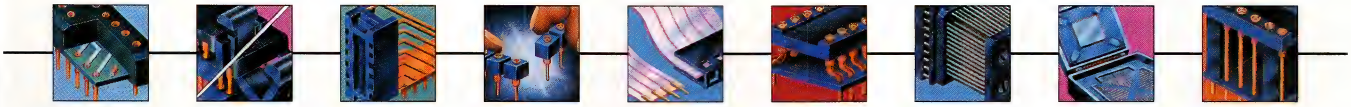

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Figures 1 or 3.

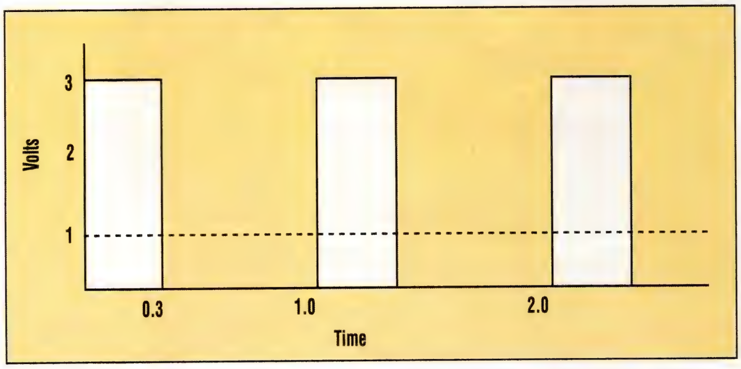
To power low-voltage microprocessors in non-portable equipment, the linear topology offers a low-cost solution without EMI, but it does generate significant heat. However, the 3.3-V microprocessors draw 2 to 4 A. At 4 A, the microprocessor dissipates 13.2 W while the linear converter dissipates 6.8 W. Because extra design effort and cost are needed to remove the microprocessor-generated heat anyway, it's likely that the converter's smaller heat load will require little, if any, extra cost.

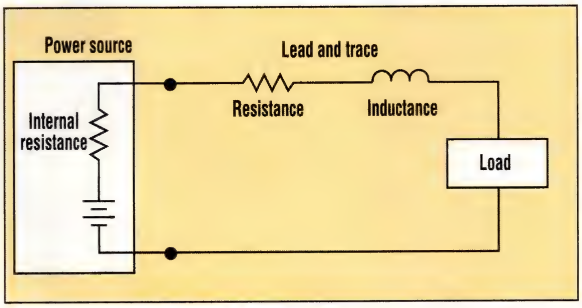
But now consider applying the linear topology to a more compact portable design. Assuming first that there are batteries available to supply more than 4 A for any length of time, the high power consumption of the linear topology— 6.8 W versus only 1.3 W for a switcher—argues strongly against its use. Now it's best to more closely look at some of the different switcher topologies and compare their pros and cons in portable designs.

As noted earlier, using a switcher topology is compelling because it offers high efficiency within a small, lightweight package. Although filtering is needed to clean up a switcher's input and/or output, most digital engineers are well aware of the additional cost involved. Less obvious, however, is how one switcher topology differs with others in its impact on portable-equipment operation.

Switchers owe their high efficiency to switching current on and off rapidly. Moreover, switchers operate in saturation to minimize losses, and of course, the switch doesn't dissipate power when current is switched off. Consider, for example, converting 15 V to 5 V with a buck-converter topology *(Fig. 4)* that generates a 33% duty-cycle waveform *(Fig. 5)*. By switching the current from the power source, the voltage is dropped by the ratio of the on-time to the period (duty cycle).

5. The buck-converter output generates this typical 33% duty-cycle waveform. By switching the current from the power source, the voltage is dropped by the ratio of the on-time to the period (duty cycle). These pulses can produce problems that could adversely impact battery life and efficient operation.





6. An equivalent circuit shows that any power topology packs an internal impedance, and, of course, any wiring external to the topology has resistance and inductance. Switcher-topology current pulses drawn from the power source result in a voltage drop that in turn produces significant ripple on the dc output. Add the wiring and connector resistance, and ripple now becomes a major pitfall to avoid.

This means that for a current drain of 1 A at 5 V, the 15-V source must supply pulses of at least 3 A. This leads to two knotty problems.

The first problem arises because of the exponential relationship between battery life and drain current. Although the average current drain may seem acceptable, the pulses may significantly shorten battery life.

The second problem is more subtle. Any source of power contains an internal impedance, and any external wiring has resistance and inductance. As large current pulses are drawn from the power source, they produce a voltage drop (current multiplied by the internal impedance) *(Fig. 6)*. With a typical internal impedance of 0.1 Ω and a 3-A pulse, the 15-V supply now generates a ripple of 300 mV. Add the wiring and connector resistance, and ripple now becomes a huge headache.

Switcher designs typically push to operate at higher and higher frequencies to further improve efficiency and reduce both size and weight. At higher frequencies, long wires and traces start becoming significant inductors. Now there's a new source of ripple (and spikes)—L di/dt—again generated external to the switcher topology.

When a supply causes data losses, the tendency is to suspect the output when the problem here is actually at the input. Another topology-dependent source of ripple occurs when the duty cycle is short and the current pulses are high. In such cases, the power source sags due to its slow loop response.

Another major hidden pitfall deals with large ground-current pulses. When this occurs, resistance and inductance in the ground return can lift the ground reference for the logic at high-current points. Suddenly, ground is not where it seems.

In general, the buck regulator is the lowest-cost switcher because of its lower component count and simple magnetics. Linear Technology Corp., Milpitas, Calif., and National Semiconductor Corp., Santa Clara, Calif., among others, have made them simple and cost-effective with one-chip solutions. Because no isolation exists between the input and output, it's possible for the input voltage to be applied to the output if the device fails. This could be a very serious hazard when input voltages are high. Of course, when using batteries, there's no need for isolation. And when operating a buck converter from a power supply that converts ac to dc, the supply offers safe isolation.

Today's power-supply gurus seem to be most enthusiastic about a new switcher topology called "resonant-mode" *(Fig. 7)*. Although it doesn't look substantially different than other

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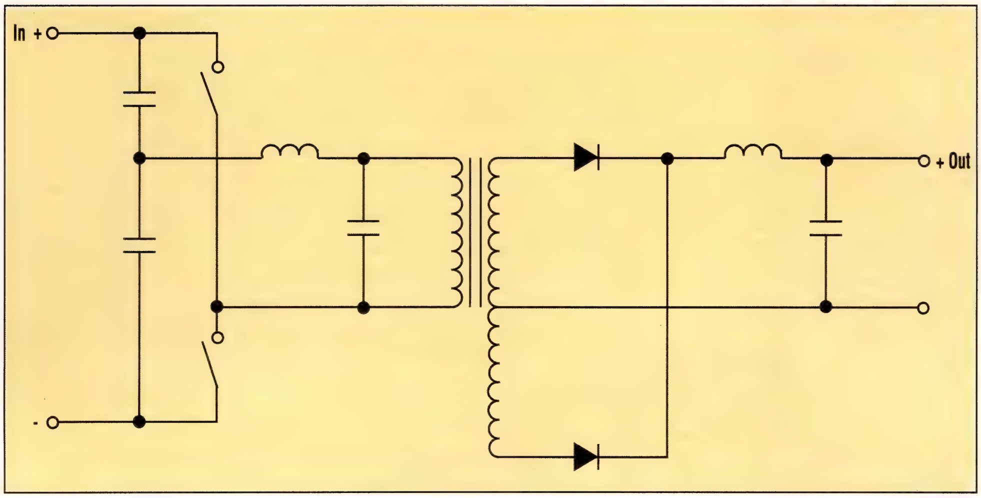
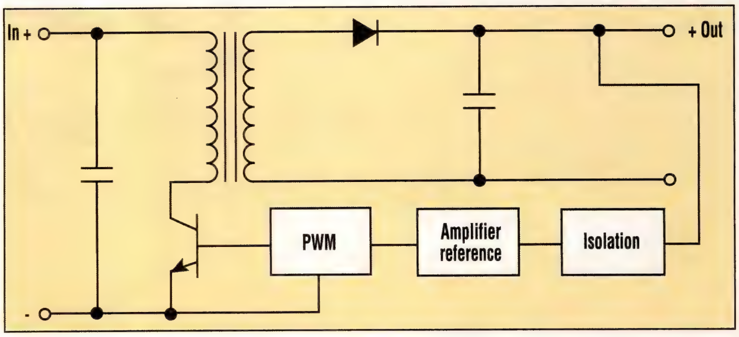
switcher topologies, it does present new trade-offs. Basic to resonant-mode operation is switching the power on and off at either the point of no current or no voltage (hence resonant). This substantially reduces stress in switching semiconductors, which cuts their cost and improves their long-term reliability. In some cases, the waveforms are also less prone to produce some of the noise problems discussed previously.

Although the resonant-mode topology looks like an optimal solution, one drawback is that its regulation depends upon frequency variation. It was pointed out earlier that switching power supplies require filtering at both the input and output. When a converter runs at one frequency, designing and building an effective filter is much easier. Moreover, it's easy to pick a frequency that will not be at (or harmonically related to) a clock frequency. Does this mean that resonant-mode converters are unsuitable for portable computers? Of course not. It does mean, however, that special precautions must be taken to ensure that it will work properly in your portable environment.



7. A popular switching topology, the resonant-mode switcher, derives its name from its basic tenet of switching the power on and off at either the point of no current or no voltage. While this relieves stress on ICs, it presents the filtering difficulties that arise from variable-frequency regulation.



8. The pulse-width-modulated (PWM) converter incorporates a transformer that offers safe isolation and the flexibility to step voltages up or down. It also allows the converter to run at a higher duty cycle, bringing with it the benefit of lower peak currents.

The most common switcher topology in use today, the conventional pulse-width-modulated (PWM) converter, incorporates a transformer that offers safe isolation and the flexibility to step voltages up or down *(Fig. 8)*. It also allows the converter to run at a higher duty cycle, bringing with it the benefit of lower peak currents. As before, the output is regulated by varying the duty cycle. Cost rises because the transformer is more expensive than the choke, and the feedback must not destroy the isolation between input and output. Most of these converters provide 500 V of isolation and run at efficiencies of 70 to 90%.

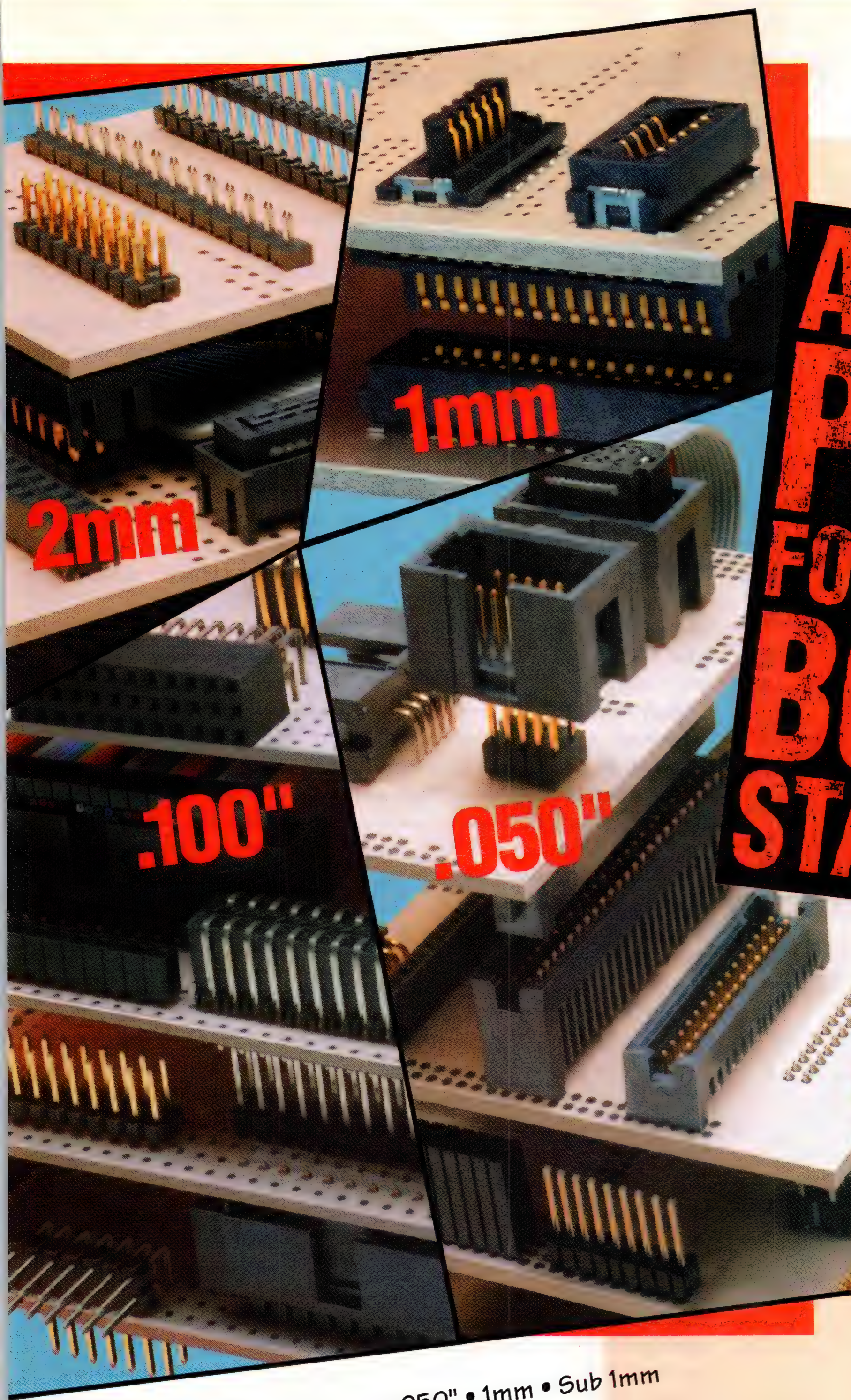
The move to lower-voltage ICs poses yet another challenge in applying a switcher topology. In deriving the lower voltages from a 5-V source, the voltage loss across the rectifier used in a switcher starts to become a dominant factor. For example, deriving a 3-V output with a Schottky rectifier results in a typical 0.3-V drop, which represents a 10% loss in efficiency. The lower the output voltage, the greater the problem.

One way to improve switcher efficiency is to replace the conventional rectifier with a synchronous rectifier. A typical case is one in which the rectifier is shunted by a low on-resistance power FET. As you might expect, the added complexity and the need for a very low on-resistance FET adds to the cost. If battery life is the major consideration, however, then this becomes a compelling choice.

Microprocessors operating at 3.3 V consume 2 to 4 A and require tight regulation. Even as low as 2 A, the maximum contact resistance allowable through the cable, connector, and traces totals only 0.05 Ω—with the ideal power supply. But in the real world, allowance must be given for some initial accuracy tolerance and drift with load and temperature. Thus, a guarantee of the proper voltage is unlikely. A remote sense could be added to the 3.3-V supply, but there's still enough distributed resistance to question voltages elsewhere on the board.

What happens when the IC operates from less than 3 V? We've begun to see ICs at 2.5 V or less, and some cache controllers at 2 V. Will it be possible to adequately distribute such voltages throughout computers? Consider a small desktop system consuming only 165 W. At 3.3 V, it draws 50 A. Only 0.002 Ω puts you out of spec. If the power is distributed at an intermediate voltage, such as 12 V in a portable or 50 V in a desktop, then conversion can be made at the load with any of the topologies. For portables, there's also a boost in battery life.

One other power issue that's very subtle, but is becoming more and more critical, is noise. The explosion in wireless com-



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munications is making our environment steadily noisier. These noise sources add to the existing radiated emissions from radio, TV, and cellular phones. Moreover, the increasing use of solid-state lamps, ballasts, and variable-speed motors for energy conservation is propagating potentially hostile EMI fields in which portable equipment must operate. Mixing external unwanted frequencies with those generated by a given power topology and system clock can produce sum-and-difference frequencies that cause glitches. Such noise problems will be difficult to isolate, let alone reproduce during troubleshooting.

> **One power issue that's very subtle yet critical is noise. Noise-related glitches can be difficult to isolate or reproduce.**

Also, be aware that the newest microprocessors are now operating in the same frequency range as commercial TV and FM broadcasts. If you're in close proximity to a broadcast station, signals of 1 V or more can be generated on the wire that connects an external battery charger to a portable PC. As thresholds drop lower and operating speed rises, assuring proper operation of portable equipment becomes an even more formidable design challenge.

To summarize, even though switchers offer size, weight, and efficiency advantages, a linear topology often provides the best solution. Here's why:

- *Simple voltage reduction:* When the current is 1 A or less and isn't a significant drain on the battery, the simple Zener topology or EZ Dropper is a good choice. While a conventional Zener may generate noise, the EZ Dropper functions quietly. Because no regulation exists with these simple topologies, they should be used only where regulation isn't needed or where the input is well regulated.
- *Regulated voltage reduction:* The venerable 7800-series linear regulator is low in cost and virtually indestructible. But if the differential between input and output is less than 2 V, then either the regulated EZ Dropper topology or an LDO like the LT1083 series is a better choice. The circuit shown in Figure 3a is significantly lower in cost but doesn't contain the protection offered by the LT1083 series.

Where long battery life or low heat dissipation are key design issues, the low efficiency of linear topologies remains a drawback. A switcher solution, on the other hand, significantly boosts efficiency, but it also has much higher noise generation and costs up to ten times more. Switchers become a compelling choice when either the input spans the output (3-to-6-V input and 5-V output) or when the input voltage must be stepped up.

Before summarizing switcher solutions, here's a key point. Man's best friend may be a dog, but a switcher-topology user's best friend may be a low equivalent-series-resistance (ESR) capacitor. Most switchers run at high frequencies to shrink size and weight. And as ripple frequency increases, ordinary capacitors present a high ESR, which limits their storage and bypass capabilities. To overcome these and other problems created by the source impedance (or lead resistance and inductance) shown in Figure 6, a low-ESR capacitor should be placed at the converter's input.

Trying to distribute any significant current from a 3.3-V power source becomes futile as the current travels resistive paths to its many destinations. A better solution is distributed power. And of course, implementing dc-dc conversion in any direction but down calls for a switcher. Here's a summary of switcher solutions to consider:

- *Switcher + linear:* The switcher topology that's easiest to use compares to the vibrators used in early car radios. But where the vibrator used mechanical contacts to switch dc, switching transistors are now used with a linear regulator at the output. This topology offers a clean input and output. Not only is the input easier to filter, but the duty cycle is very high. The output is also easy to filter, and the linear regulator helps as well. If noise is a concern in datacom or data-acquisition applications, this topology is useful.
- *Buck, boost, or buck/boost:* These switcher topologies are usually the lowest cost and are relatively easy to tame—especially with a low-ESR capacitor. The main drawback is lack of isolation, which means failure could cause the input voltage to appear (via short circuit) at the output. Efficiencies are typically around 80%.
- *Conventional PWM:* This topology is best when isolation is required. Often, multiple outputs are supplied. Multiple subsets of topologies are available, such as flyback and forward converter, but they're the common converters you see today. Fortunately, designers have learned to deal with this topology's noise and EMI. Efficiency varies from 70 to over 90%.
- *Resonant mode:* The main advantages here are small size and low cost. The big problem is noise and EMI. This topology often runs at higher frequencies, reducing size and weight. But high frequencies result in both radiated and conducted emissions that are hard to contain. Containment with shielding and a wideband filter could negate any size and/or cost advantages. Efficiencies are similar to conventional PWM circuits.

As converter frequency and data rates rise, interference problems worsen. Ferrite beads are easy to use, but a filter may be the only way to go.

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Seneca, MO 64865
(417) 776-2256
(UN) (LC) (LT) (NH)
CIRCLE 646

East Penn Mfg. Co. Inc.
Deka Road
Lyon Station, PA 19536
(215) 682-6361
(LC)
CIRCLE 647

Edal Industries Inc.
4 Short Beach Rd.
East Haven, CT 06512
(203) 467-2591
(RE)
CIRCLE 648

Electroid Co.
45 Fadem Rd.
Springfield, NJ 07081
(201) 467-8100
(50S)
CIRCLE 649

Electronic Measurements
405 Essex Rd.
Neptune, NJ 07753
(908) 922-9300
(200S) (LA) (RM) (CV) (RP)
(PF) (11C) (200C) (DC) (AC)
(LI) (SW) (MU)
CIRCLE 650

Elenco Electronics Inc.
150 W. Carpenter St.
Wheeling, IL 60090
(708) 541-3800
(50S) (LA) (CV)
(LC)
CIRCLE 651

Elpac Power Systems
6527 Paseo Diego
Anaheim, CA 92714
(714) 476-6070
(50S)
CIRCLE 652

Engineered Magnetics
18435 Susana Rd.
Rancho Dominquez, CA 90221
(310) 635-9555
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (CV)
(PR) (RP) (MD) (UN) (PF)
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (AC) (MO)
(MI) (50R) (51R) (500R)
(10R) (11R) (200R) (LI)
(SW) (MU) (ML)
CIRCLE 653

Entran Devices Inc.
10 Washington Ave.
Wayne, NJ 07004
(201) 227-1002
(50S) (LA) (RM) (CV)
CIRCLE 654

(see p. 110 for key)
(continued on p. 102)

▼ 1000-W POWER SUPPLY MEETS IEC 555-2

A power factor in excess of 0.99 and compliance with IEC 555-2 specifications are featured in the model PM3386B switching power supply. The five-output, 1000-W unit comes in a compact 5-by-5-by-11-in. package. Its main output delivers up to 750 W or 150 A in the 5-V-output version. A 24-V-output version is also available. Voltages on auxiliary outputs can be factory-set to any value from 2 to 24 V dc. A wide 96-to-264-V ac input range enables worldwide operation, and the unit's high switching efficiency permits it to provide full 1000-W power from standard 15-A service. Pricing is $1095 in small quantities. Delivery is from stock.

Pioneer Magnetics
1745 Berkeley St.
Santa Monica, CA 90404
(310) 829-6751
▶ CIRCLE 803

▼ 250-W SWITCHER WON'T HOG SPACE

Measuring only 2 in. tall by 4.5 in. wide by 9 in. long, the Series 2A power supplies are claimed as the industry's smallest 250-W, multi-output switchers. The 10 models in the series provide three or four well-regulated dc outputs. The main output is rated 5 V at 30 A. Two or three auxiliary outputs are 12 or 15 V at 10 A; 12 or 15 V at 3 A; and 5 V, 12 V at 3 A or 24 V at 2 A. There are also models with wide-range, user-adjustable auxiliary outputs. Line and load regulation are rated at 0.2% and 0.8% or better, respectively. Ripple and noise are rated at 1% p-p maximum. OEM-quantity pricing is $270. Delivery of sample quantities is in six weeks.

Lambda Qualidyne Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
▶ CIRCLE 804

"A great time to introduce a new luxury cruise line. The economy was in a slump, and the competition was on the rise.

"Increasing our ad budget was so successful, our agency recommended we cut it."

We told our new advertising agency we have to go in with all guns blazing. And gave them the extra money to do it.

They recommended a three phase campaign. Phase 1. Full page newspaper. One ad a week for 24 weeks and one-third pages in the travel section. Phase 2, radio. Then 3, television to sweep up one season and sow the seeds for the next.

To make a long story short, two-thirds into the newspaper phase, Celebrity's ships were just about full to the end of the season. With so little left to sell, we all agreed to hold the radio and TV and save the remainder of the budget.

In roughly two years Celebrity became the number one cruise line from New York to Bermuda.

We've just added another new luxury ship and we're anxious to fill it. So once again we've upped our budget. So far, our agency hasn't tried to talk us out of it."

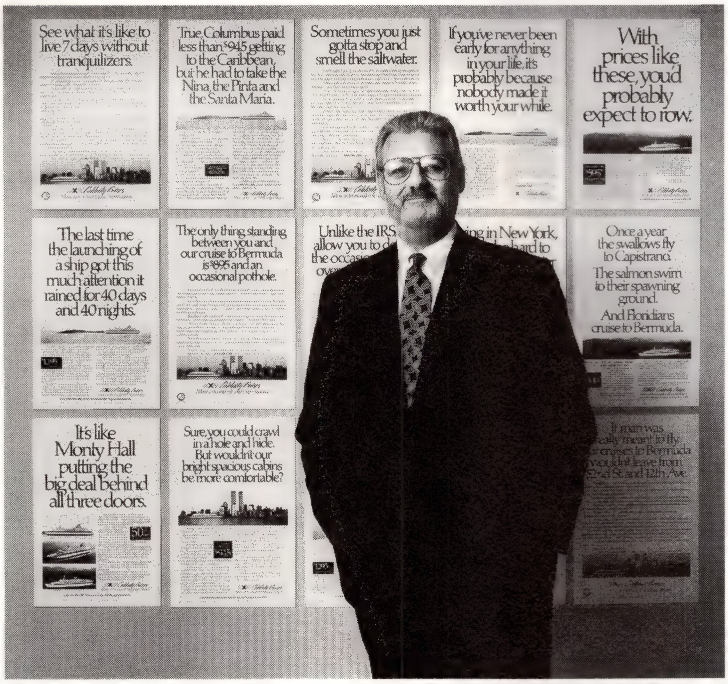

See what it's like to live 7 days without tranquilizers.
True, Columbus paid less than $945 getting to the Caribbean, but he had to take the Nina, the Pinta and the Santa Maria.
Sometimes you just gotta stop and smell the saltwater.
If you've never been early for anything in your life, it's probably because nobody made it worth your while.
With prices like these, you'd probably expect to row.
The last time the launching of a ship got this much attention it rained for 40 days and 40 nights.
The only thing standing between you and our cruise to Bermuda is $895 and an occasional pothole.
Once a year the swallows fly to Capistrano. The salmon swim to their spawning ground. And Floridians cruise to Bermuda.
It's like Monty Hall putting the big deal behind all three doors.
Sure, you could crawl in a hole and hide. But wouldn't our bright spacious cabins be more comfortable?

Photo: Frank Moscati

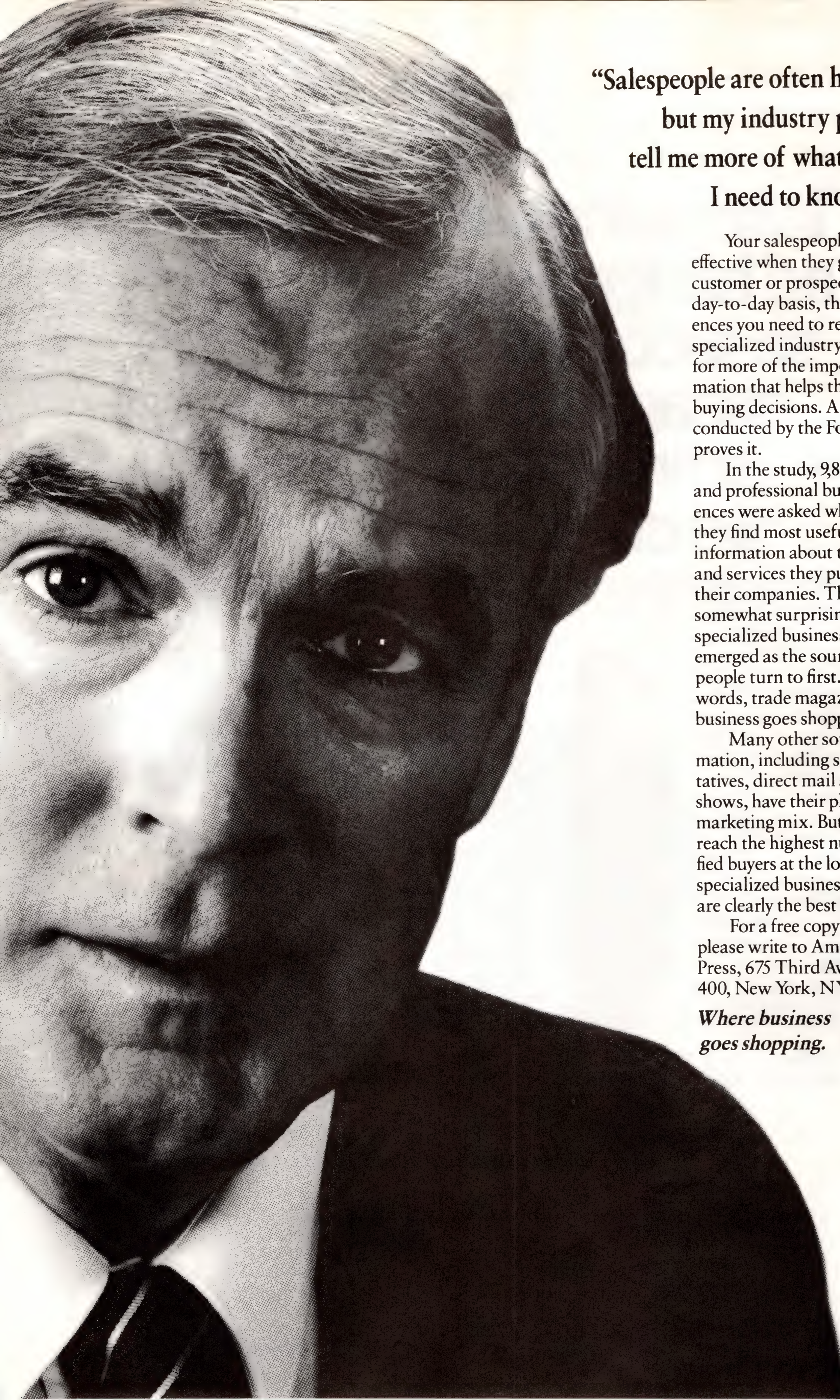
Al Wallack, Sr. VP Marketing, Celebrity Cruises, after returning from having his hearing checked.

AAAA

American Association of Advertising Agencies

If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, NY 10017 enclosing a check for five dollars. You will receive our booklet, *It Works! How Investment Spending In Advertising Pays Off.* Please allow 4 to 6 weeks for delivery.

This advertisement prepared by Korey, Kay & Partners, New York.



"Salespeople are often helpful, but my industry publications tell me more of what I need to know."

Your salespeople can be effective when they get to see a customer or prospect. But, on a day-to-day basis, the buying influences you need to reach turn to specialized industry publications for more of the important information that helps them make buying decisions. A recent study, conducted by the Forsyth Group, proves it.

In the study, 9,823 business and professional buying influences were asked what sources they find most useful in providing information about the products and services they purchase for their companies. The results were somewhat surprising. Overall, specialized business publications emerged as the source business people turn to first. In other words, trade magazines are where business goes shopping.

Many other sources of information, including sales representatives, direct mail and trade shows, have their place in the total marketing mix. But if you want to reach the highest number of qualified buyers at the lowest cost, specialized business publications are clearly the best choice.

For a free copy of the study, please write to American Business Press, 675 Third Avenue, Suite 400, New York, NY 10017.

Where business goes shopping. **ABP**

"I'm a vice president because I sold 22,000 gizmos this year. How'd you become a v.p.?"
"I made a great deal on the 200,000 gizmos you didn't sell last year."

Turn your **excess inventory** into a tax break and help send needy **kids to college**.

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Power Products Group
403 International Pkwy.
Richardson, TX 75081
(214) 997-6561
(51C) (11C) (DC)
CIRCLE 655

Eveready Battery
Energizer Power Systems
P.O. Box 147114
Gainesville, FL 32614-7114
(904) 462-3911
(AL) (CZ) (LT) (ME) (NC)
(NM) (SO) (ZA) (ZC)
CIRCLE 656

Fedco Electronics Inc.
P.O. Box 1403
Fond Du Lac, WI 54936
(800) 542-9761
(AL) (CZ) (LC) (LT) (ME)
(NC) (NM)
CIRCLE 657

Fluke Corp.
Diagnostic Tools Div.
6920 Seaway Blvd.
Everett, WA 98203
(206) 356-6459
(51S) (11S) (LA) (RM)
(CV) (RP)
CIRCLE 658

Fortron/Source Corp.
2925 Bayview Dr.
Fremont, CA 94538
(510) 440-0188
(50S) (11S) (200S) (OF) (50C)
(10C) (DC) (AC) (LI) (SW)
CIRCLE 659

Gamma High Voltage
Research
1096 N. U.S. Hwy. #1
Ormond Beach, FL 32174
(904) 677-7070
(51S) (500S) (10S) (11S)
(200S) (LA) (RM) (CV) (RP)
(51C) (500C) (10C) (11C)
(200C) (DC) (MO)
CIRCLE 660

Gates Energy Products Inc.
Industrial Battery Div.
617 N. Ridgeview Dr.
Warrensburg, MO 64093-9301
(816) 429-2165
(LC)
CIRCLE 661

Glassman High Voltage
P.O. Box 551
Whitehouse Station, NJ 08889
(908) 534-9007
(500S) (200S) (LA) (RM)
(CV) (RP) (PF)
CIRCLE 662

Golden Systems Inc.
2125-B Madera Rd.
Simi Valley, CA 93065
(805) 582-4400
(50S) (10S) (11S) (200S)
(OF) (CV) (PF)
CIRCLE 663

Harris Semiconductor
Semiconductor Products
Div.
P.O. Box 883
Melbourne, FL 32902
(407) 724-3802
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 664

Hewlett-Packard Co.
New Jersey Div.
150 Green Pond Rd.
Rockaway, NJ 07866
(201) 586-5637
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM)
(CV) (RP)
CIRCLE 665

Hydrocap Corp.
975 N.W. 95th St.
Miami, FL 33150-2095
(305) 696-2504
(LC) (NC)
CIRCLE 666

IXYS Corp.
3540 Bassett St.
Santa Clara, CA 95054
(408) 982-0700
(MF) (RE) (TH) (PI) (PC)
CIRCLE 667

International Power
DC Power Supplies Inc.
360 Bernoulli Cir.
Oxnard, CA 93030-5167
(805) 981-1188
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (LI)
CIRCLE 668

International Power Devices
20 Linden St.
Boston, MA 02134
(617) 782-3331
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (PF) (50C)
(51C) (10C) (11C) (200C)
(DC) (MO) (IC)
CIRCLE 669

International Power Sources
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-7434
(50S) (51S) (500S) (10S)
(11S) (LA) (RM) (50C)
(51C) (500C) (10C) (11C)
(DC) (MO) (SW)
CIRCLE 670

Interpoint
Power Products Div.
10301 Willows Rd.
Redmond, WA 98052
(206) 882-3100
(50C) (10C) (11C) (DC) (MI)
CIRCLE 671

James Electronics Inc.
4050 N. Rockwell St.
Chicago, IL 60618
(312) 463-6500
(50S) (10S) (11S) (200S)
(RM) (OV) (CV)
CIRCLE 672

Jerome Industries Corp.
730 Division St.
Elizabeth, NJ 07201
(908) 353-5700
(50S) (10S) (OF) (CV)
(UN) (10C) (DC)
CIRCLE 673

Jeta Power Systems Inc.
2675 Junipero Ave.
Signal Hill, CA 90806
(310) 427-0095
(50S) (200S) (CV) (PF) (200C)
(DC) (200R) (SW)
CIRCLE 674

K&M Electronics Inc.
11 Interstate Dr.
West Springfield, MA 01089
(413) 781-1350
(500S) (MD) (500C) (DC) (MI)
CIRCLE 675

Kepco Inc.
131-38 Sanford Ave.
Flushing, NY 11352
(718) 461-7000
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM) (OF)
(CV) (RP) (PF) (50C) (10C)
(11C) (200C) (DC) (MO) (50R)
(LI) (SW) (MU)
CIRCLE 676

Kikusui International Corp.
1980 Orizaba Ave.
Signal Hill, CA 90804-1203
(800) 545-8784
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM) (CV)
(PR) (RP) (50R) (51R) (500R)
(10R) (11R) (200R) (LI) (SW)
CIRCLE 677

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747-3700
(516) 694-4200
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (OF) (CV)
(PR) (RP) (MD) (UN) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (MO) (MI) (50R)
(51R) (10R) (11R) (200R)
(LI) (SW) (MU)
CIRCLE 678

Lambda Novatronics Inc.
500 S.W. 12th Ave.
Pompano Beach, FL 33061
(305) 942-5200
(50S) (51S) (11S) (200S)
(RM) (OF) (CV) (PF) (50C)
(51C) (11C) (200C) (DC) (MO)
(MI) (50R) (51R) (11R) (200R)
(LI) (SW) (MU) (ML)
CIRCLE 679

Lambda Qualidyne Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
(50S) (200S) (RM) (CV) (RP)
(PF) (50C) (200C) (DC) (MO)
(50R) (200R) (SW) (MU)
CIRCLE 680

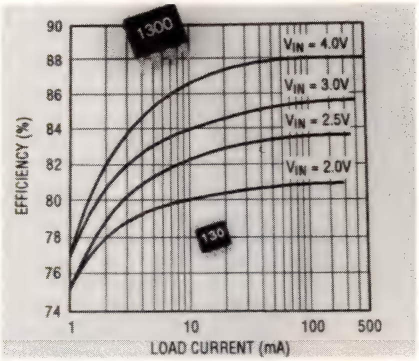
Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035
(408) 432-1900
(50C) (51C) (10C) (11C) (DC)
(IC) (MI) (50R) (51R) (10R)
(11R) (LI) (SW) (ID) (ML) (PC)
CIRCLE 681

Logitek Inc.
101 Christopher St.
Ronkonkoma, NY 11779
(516) 467-4200
(50S) (11S) (200S) (CV)
(MD) (PF) (50C) (11C) (200C)
(DC) (MO) (MI) (50R) (11R)
(200R) (SW) (MU) (ML)
CIRCLE 682

(see p. 110 for key)
(continued on p. 104)

▼ STEP-UP CONVERTERS NEED ONLY INDUCTORS

A full 250 mA of output current at 5 V can be supplied from a 2-V supply by the LT1300 dc-dc converter. The IC, which has applications in palmtop computers, portable instruments, hand-held barcode scanners, and more, provides efficiencies of up to 88% from supplies as low as 1.8 V. Quiescent current is 120 µA and the device can be shut down to 10 µA of standby current. Only 2-µH surface-mount inductors are required for operation thanks to the device's 150-kHz minimum switching frequency. Pricing in lots of 100 is $3 in an 8-pin DIP and $3.20 in an 8-lead SOIC. Samples are available now.



Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035-7487
(800) 637-5545
▶ **CIRCLE 805**

▼ 100-W CONVERTERS MEASURE 0.8-IN. WIDE

Designed for telecommunications and distributed-power architectures, the CQ Family of 100-W dc-dc converters is comprised of fully integrated systems combining heat sinks, transient suppression, input and output filtering, control, and shock and vibration immunity in a very thin, hot-swappable package. The units quickly slide into a 3U VME rack. Up to 16 CQ converters fit in one 19-in. rack. Input-voltage range is from 38.4 to 75 V dc. Continuous surges of up to 100 V dc will not harm the supplies, and no minimum load is required for regulation. Pricing starts at $380 in lots of 100. Delivery is from stock.

Melcher Inc.
187 Billerica Rd.
Chelmsford, MA 01824
(800) 828-9712
▶ **CIRCLE 806**

Interpoint's MIL-STD-883 dc-dc converters:

Recognized for outstanding performance.

On Space Station Freedom, the Patriot Missile, European Fighter Aircraft and thousands of critical applications, Interpoint dc-dc converters are the ones designers choose first. However you measure performance, Interpoint commands the field.

HI-REL DC-DC Converters for Every Power Level

Series	V in	V out	Outputs	Power
MSA	16 to 40	5,12,15	1 or 2	5 W
MHF+	16 to 40	5,12,15	1 or 2	15 W
MTR	16 to 40	5,12,15	1, 2, or 3	30 W
MFL	16 to 40 80 to 160 160 to 400	5,12,15,28	1 or 2	65 W*
MFLHP	19 to 40	5,12,15	1 or 2	100 W*

** Multiple units current share*

Interpoint is recognized for broadest selection. From fully qualified SMD parts to low-cost solutions, from 5 to 285 watts. Interpoint has a solution for almost every power need.

Interpoint is recognized for innovation. Our 20-year history of breakthroughs includes the first 70 W/in^3 board-mountable dc-dc converters.

Interpoint is recognized for reliability. Our power supplies have logged more than 1,000,000 field hours per failure.

Our new, fully compliant MSA Series offers 5 watts of power in a case just 0.27" high. The MSA also meets MIL-STD-704A input voltages (up to 80V surges) with 5, 12, and 15 Vdc outputs.

For your **FREE HI-REL DESIGN FIELD KIT,** with Guides to selecting and using dc-dc converters in HI-REL systems, call:

NEW!
The 5-watt
MSA Series
now meets
MIL-STD-883

1-800-822-8782

In Europe, call:
Interpoint U.K. (0252) 815511
Interpoint France (1) 34-28-54-55

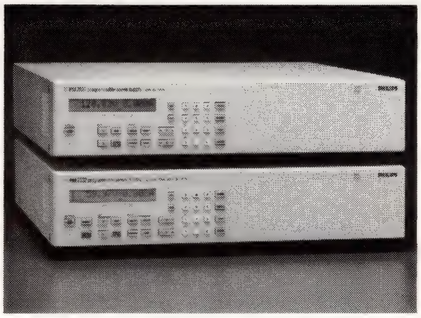
interpoint

CIRCLE 180 FOR U.S. RESPONSE

CIRCLE 181 FOR RESPONSE OUTSIDE THE U.S.

▼ PROGRAMMABLE LINEARS SUIT DIGITAL TASKS

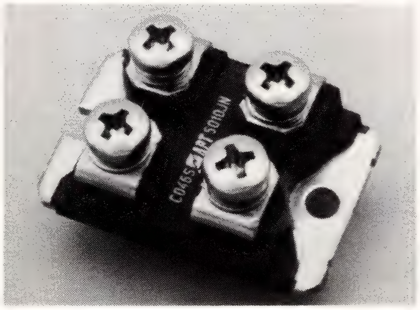
Two additions to the PM 2800 family of linear programmable power supplies feature high-current-output capability, which makes them suitable for digital applications. The PM 2831 provides 120-W, single-output operation at up to 8 V and 15 A; while the PM 2832 offers 240 W and dual outputs at up to 16 V and 30 A. Both are linear supplies with fast response times and low noise levels. Output settings can be programmed with 2-mV and 0.75-mA resolution. Both also are designed for system environments, offering easy programmability and support for IEEE 488.2 and the standard commands for programmable instruments (SCPI). Pricing for the PM 2831 and PM 2832 supplies is \$2095 and \$3595, respectively. Delivery is in four weeks.



Fluke Corp.
P.O. Box 9090
Everett, WA 98206
(800) 44-FLUKE
▶ CIRCLE 807

▼ HIGH-VOLTAGE MOSFET COMES IN SOT-227

A high-voltage, very low $R_{DS(ON)}$ single-die MOSFET is offered in the industry-standard SOT-227 package. The J-Pack MOSFET is available with a BV_{DSS} of from 200 to 1000 V and $R_{DS(ON)}$ of 0.040 to 0.5 Ω, respectively. Similarly, the I_D is rated at from 77 to 20.5 A, respectively, and the P_D is rated at 520 W. Sample quantities are available from stock with volume deliveries running from four to eight weeks. In lots of 1000, prices range from \$25 to \$45 each.



Advanced Power Technology
405 S.W. Columbia St.
Bend, OR 97702
(503) 382-8028
▶ CIRCLE 808

▼ MULTI-OUTPUT SUPPLIES PACK PFC AT LOW COST

A series of low-cost, multiple-output supplies offers power-factor correction to IEC 555-2 requirements. The PFC Series supplies are available in 300-, 500-, 750-, and 1000-W packages with configural options for three, four, or five outputs. To ease the task of integrating the units into system applications, they incorporate independently regulated outputs with no preload requirements. In addition, each output has wide-range output-voltage adjustment with high-current capability. The supplies' low 2.65-in. height fits tight spots. A 1000-W, power-factor-corrected supply starts at \$475.

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747
(516) 694-4200
▶ CIRCLE 809

POWER-SOURCE MANUFACTURERS

Lutze Inc.
1911-A Associates Ln.
Charlotte, NC 28217
(704) 357-8835
(50S) (OF) (CV) (UN)
(DC) (AC) (MO)
CIRCLE 683

MIL Electronics Inc.
One Chestnut St.
Nashua, NH 03063
(603) 882-3200
(50S) (51S) (500S) (10S)
(11S) (CV) (RP) (MD) (50C)
(51C) (500C) (10C) (11C)
(DC) (MO) (MI) (50R) (51R)
(500R) (10R) (11R) (LI)
(SW) (MU) (ML)
CIRCLE 684

Maxim Integrated Products
120 San Gabriel Dr.
Sunnyvale, CA 94086
(408) 737-7600
(50C) (51C) (10C) (11C) (DC)
(IC) (50R) (51R) (10R) (11R)
(LI) (SW) (ID) (PI) (PC)
CIRCLE 685

Melcher Inc.
187 Billerica Rd.
Chelmsford, MA 01824
(800) 828-9712
(50S) (10S) (11S) (200S) (RM)
(RP) (MD) (50C) (10C) (11C)
(200C) (DC) (IC) (MI) (50R)
(10R) (11R) (200R) (MU) (ID)
CIRCLE 686

Micrel Semiconductor
1849 Fortune Dr.
San Jose, CA 95131
(408) 944-0800
(PI) (PC)
CIRCLE 687

Micro Linear Corp.
2092 Concourse Dr.
San Jose, CA 95131
(408) 433-5200
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (IC)
(50R) (51R) (500R) (10R)
(11R) (200R) (LI) (SW)
(ID) (PI) (PC)
CIRCLE 688

MicroEnergy Inc.
Engineering Div.
745 W. State Rd., 434
Longwood, FL 32750-4909
(407) 831-2000
(50S) (51S) (RM) (OF) (CV)
(PR) (PF) (50C) (DC) (50R)
(51R) (11R) (200R) (SW)
CIRCLE 689

Modular Devices Inc.
4115 Spencer St.
Torrance, CA 90503
(310) 542-8561
(50S) (11S) (200S) (RM)
(OF) (CV) (RP) (PF) (11C)
(200C) (DC) (MO)
CIRCLE 690

Modular Devices Inc.
1 Roned Rd.
Shirley, NY 11967
(516) 345-3100
(50S) (51S) (500S) (10S)
(11S) (200S) (MD) (PF)
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (AC)
(MO) (IC) (MI)
CIRCLE 691

Motorola
Power Products Div.
5005 E. McDowell Rd.
Phoenix, AZ 85008
(602) 244-5757
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 692

Multiplier Industries
P.O. Box 630, Radio Circle
Mt. Kisco, NY 10549
(914) 241-9510
(AL) (LC) (NC) (NM) (ZA)
CIRCLE 693

NH Research Inc.
6601 Hale Ave.
Irvine, CA 92714
(714) 474-3900
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (CV) (PR)
(RP) (MD)
CIRCLE 694

Natel Engineering Co. Inc.
Power Microelectronics Div.
845 Rancho Conejo Blvd.
Newbury Park, CA 91320
(805) 376-5500
(50R) (10R) (LI) (BT)
(MF) (RE) (TH)
CIRCLE 695

National Custom Enterprises
400 Gateway Blvd.
Burnsville, MN 55337-2559
(612) 890-1360
(AL) (CZ) (LC) (LT) (NC)
(NM) (SO) (ZA)
CIRCLE 696

National Semiconductor
Analog - Power Management
2900 Semiconductor Dr.
Santa Clara, CA 95052
(408) 721-2511
(50C) (51C) (DC) (IC) (MI)
(51R) (LI) (SW) (ID) (ML)
(BT) (MF) (RE) (PI) (PC)
CIRCLE 697

Nova Electric
Div. of Technology Dynamics
100 School St.
Bergenfield, NJ 07621
(201) 385-0500
(200S) (RM) (PR) (MD) (UN)
(PF) (200C) (AC) (MI)
CIRCLE 698

OECO Corp.
4607 S.E. International Way
Milwaukie, OR 97222
(503) 659-7932
(50S) (51S) (500S) (11S)
(200S) (RM) (OF) (RP) (MD)
(PF) (50C) (51C) (500C) (11C)
(11C) (200C) (DC) (MO) (MI)
CIRCLE 699

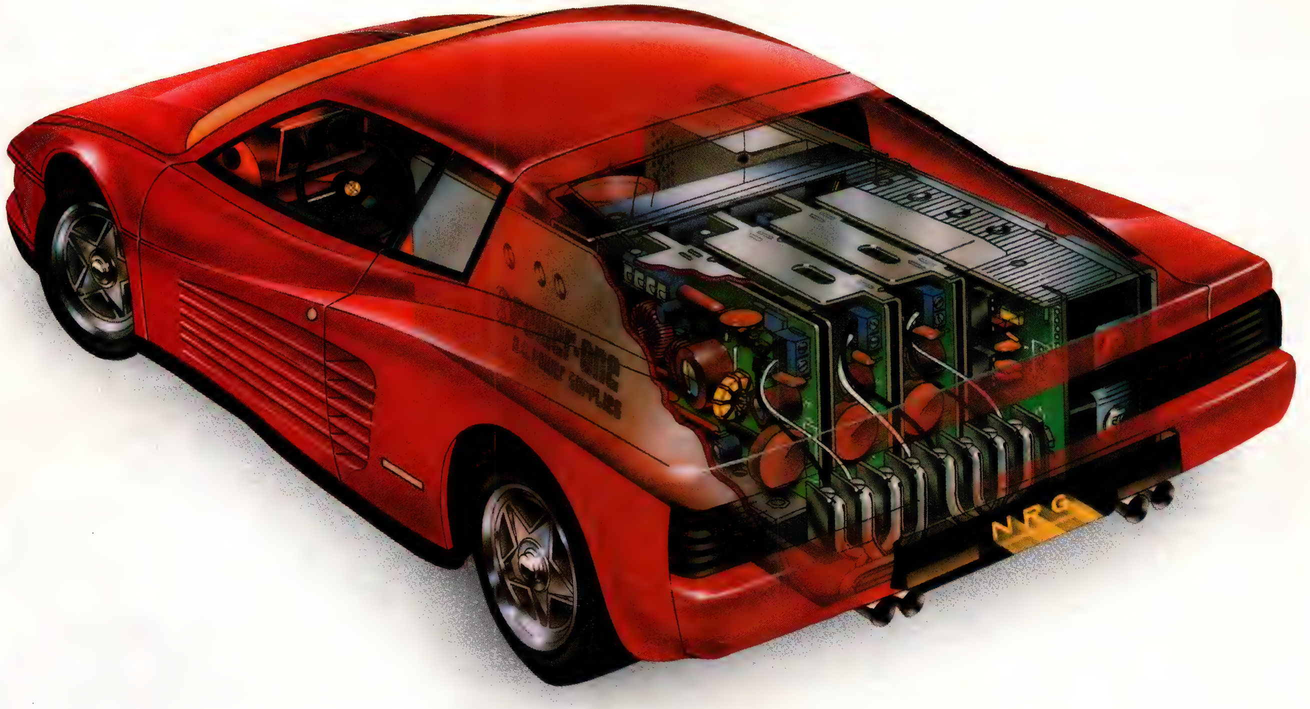
ONEAC Corp.
27944 N. Bradley Rd.
Libertyville, IL 60048
(800) 327-8801
(11S) (200S) (UN)
CIRCLE 700

OPT Industries Inc.
300 Red School Ln.
Phillipsburg, NJ 08865
(908) 454-2600
(50S) (51S) (200S) (RM) (OF)
(CV) (MD) (UN) (PF) (50C)
(51C) (200C) (DC) (MI) (50R)
(51R) (200R) (LI) (SW) (ML)
CIRCLE 701

(see p. 110 for key)

(continued on p. 106)

0 TO 550 WATTS IN TWO WEEKS



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Power-One
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- Power fail signal
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- IEC601/UL544 certification
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- Custom interface signals

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CIRCLE 702

Omnirel Corp.
205 Crawford St.
Leominster, MA 01611
(508) 534-5776
(50C) (11C) (DC) (50R) (LI) (SW) (ML) (BT) (MF) (RE)
CIRCLE 703

Onan Power/Electronics
9713 Valley View Rd.
Minneapolis, MN 55344-3508
(612) 943-4600
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CIRCLE 704

Panasonic Industrial Co.
Battery Sales Group
Two Panasonic Way
Secaucus, NJ 07094
(201) 348-5266
(AL) (CZ) (LC) (LT) (NC) (NM) (SO) (ZA) (ZC)
CIRCLE 705

Philips
Power Systems Div.
Boulevard de l'Europe 131
1301 Wavre, Belgium
(32) 10 438502
(50S) (51S) (10S) (11S) (200S) (RM) (OF) (UN) (PF) (50C) (DC) (MO)
CIRCLE 706

Phoenix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111-0100
(717) 944-1300
(50S) (10S) (11S) (LA) (CV) (10C) (11C) (DC) (MO) (50R) (10R) (11R) (LI) (SW) (MU)
CIRCLE 707

Pico Electronics Inc.
453 N. MacQuesten Pkwy.
Mount Vernon, NY 10552
(914) 699-5514
(50S) (10S) (11S) (OF) (PR) (MD) (50C) (51C) (500C) (10C) (11C) (DC) (MO) (IC) (MI)
CIRCLE 708

Pioneer Magnetics Inc.
1745 Berkeley St.
Santa Monica, CA 90404
(310) 829-6751
(50S) (51S) (11S) (200S) (RM) (UN) (PF) (50C) (51C) (11C) (200C) (DC) (AC) (MO) (50R) (51R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 709

Portable Energy Products
940 Disc Dr.
Scotts Valley, CA 95066
(408) 439-5100
(LC)
CIRCLE 710

Power Conversion Products Inc.
42 East St., P.O. Box 380
Crystal Lake, IL 60039-0380
(815) 459-9100
(50S) (51S) (RM) (CV) (PF) (50C) (DC)
CIRCLE 711

Power Convertibles
Div. of Burr Brown
3450 S. Broadmont Dr.
Tucson, AZ 85715
(602) 628-8292
(51S) (51S) (10S) (11S) (OF) (CV) (RP) (PF) (50C) (51C) (10C) (11C) (DC) (AC) (MO) (IC) (50R) (10R) (SW) (MU) (ID)
CIRCLE 712

Power General
152 Will Dr.
Canton, MA 02021
(617) 828-6216
(50S) (10S) (11S) (200S) (OF) (50C) (10C) (11C) (DC) (MO) (IC)
CIRCLE 713

Power Integrations Inc.
411 Clyde Ave.
Mountain View, CA 94043
(415) 960-3572
(PI) (PC)
CIRCLE 714

Power Solutions Inc.
4699 N. Federal Hwy.
Pompano Beach, FL 33064
(516) 627-5628
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (CV) (50C) (51C) (10C) (11C) (200C) (DC) (MO) (50R) (10R) (LI) (SW) (MU)
CIRCLE 715

Power Ten Inc.
486 Mercury Dr.
Sunnyvale, CA 94086
(408) 738-5959
(50S) (51S) (500S) (200S) (LA) (RM) (CV) (RP) (MD) (SW) (ML)
CIRCLE 716

Power Trends Inc.
1101 N. Raddant Rd.
Batavia, IL 60510
(708) 406-0900
(50C) (DC) (MO) (50R) (SW) (MU)
CIRCLE 717

Power-One Inc.
740 Calle Plano
Camarillo, CA 93012
(805) 987-8741
(50S) (51S) (10S) (11S) (200S) (OF) (CV) (UN) (PF) (LI) (SW) (MU)
CIRCLE 718

Power-Sonic Corp.
3106 Spring St.
Redwood City, CA 94063
(415) 306-1186
(LC) (NC)
CIRCLE 719

PowerTech Inc.
0-02 Fair Lawn Ave.
Fair Lawn, NJ 07410
(201) 791-5050
(BT) (PC)
CIRCLE 720

Powercard Corp.
393 Totten Pond Rd.
Waltham, MA 02154-2014
(617) 890-6789
(AL) (CZ) (LT)
CIRCLE 721

Powercube Corp.
8 Suburban Park Dr.
Billerica, MA 01821
(508) 667-9500
(50S) (10S) (11S) (200S) (CV) (RP) (MD) (50C) (10C) (11C) (200C) (DC) (MO) (MI) (50R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 722

Powerex Inc.
200 Hillis St.
Youngwood, PA 15697-1800
(412) 925-7272
(BT) (TH)
CIRCLE 723

RO Associates Inc.
246 Caspian Dr.
Sunnyvale, CA 94089
(408) 744-1450
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CIRCLE 724

Rantec Corp.
Power Systems Div.
24003 Ventura Blvd.
Calabasas, CA 91302
(603) 635-3292
(50S) (51S) (500S) (200S) (MD) (PF) (50C) (51C) (DC) (AC) (MO) (MI) (LI) (SW) (MU) (ML)
CIRCLE 725

Rantec Microwave & Electronics
1173 Los Olivos Ave.
Los Osos, CA 93402
(805) 528-5858
(500S) (10S) (11S) (OF) (CV) (MD)
CIRCLE 726

Rayovac Corp.
P.O. Box 44960
Madison, WI 53744-4960
(608) 275-4589
(AL) (CZ) (LT) (SO) (ZA) (ZC)
CIRCLE 727

Raytheon Co.
Missile Div.
465 Centre St.
Quincy, MA 02169
(617) 984-8493
(50C) (11C) (DC) (50R) (LI) (ML)
CIRCLE 728

(see p. 110 for key)

(continued on p. 108)

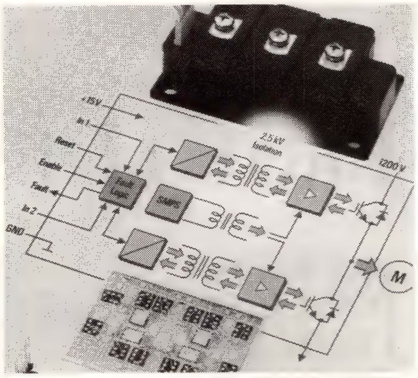
▼ RECHARGEABLE ALKALINES OFFER LONG LIFESPAN

High performance and long shelf life are now combined with rechargeability in an alkaline battery. The Renewal reusable alkalines can be recharged 25 times or more. They come fully charged and will last virtually as long as a single-use alkaline on the first cycle and three times longer than a fully charged nickel cadmium battery. The Renewal batteries have a shelf life of five years. They have an open-circuit voltage of 1.55 V and a sloping discharge profile. The batteries come in AAA, AA, C, and D sizes. Call for pricing and delivery.

Rayovac Corp.
P.O. Box 44960
Madison, WI 53744-4960
(608) 275-3340
▶CIRCLE 810

▼ INTELLIGENT IGBTs ARE EASY TO USE

The VIE 150-12S Isosmart family of IGBT power modules features a fully isolated gate drive and dual 1200-V/150-A-rated IGBTs connected as a half-bridge with built-in protection against accidental short circuits. The VIE family consists of three members rated at 75, 100, and 150 A (VIE 75-12S, 100-12S, and 150-12S, respectively). All are capable of operation up to 20 kHz. Applications are found in ac and dc motor controls and UPS systems, among others. Pricing in quantities of 10 is $228.15 for the VIE 150-12S with prototyping quantities available from stock. Same-quantity pricing for the VIE 100-12S and 75-12S is $152.75 and $113.75, respectively.

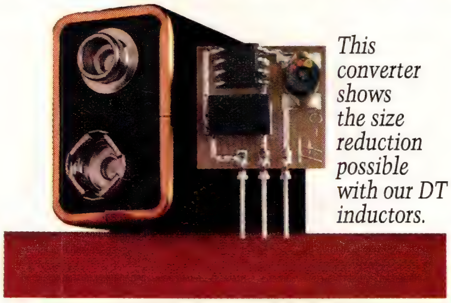


IXYS Corp.
3540 Bassett St.
Santa Clara, CA 95054
(408) 982-0700
▶CIRCLE 811

How dense can you get?

← 1/2″ →

These remarkable new ultraminiature inductors can shrink your DC-DC converters to the bare minimum.



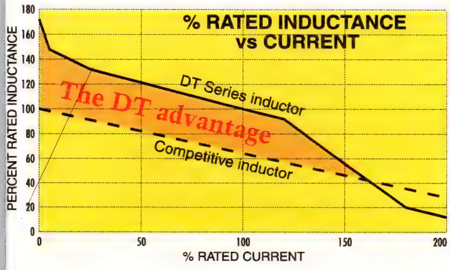
This converter shows the size reduction possible with our DT inductors.

Coilcraft's DT Series inductors represent a significant breakthrough in size, performance and price.

Thanks to our exclusive **L-tra**™ magnetics enhancement technology, you get exceptionally high inductance and current capability in a small footprint part.

"Swinging" inductance

Unlike other DC-DC converter inductors, these parts provide very high L at zero or low current. This "swinging" inductance characteristic is especially desirable in converters that have varying load currents. It eliminates the need to use an excessively large inductor to accommodate small or no load conditions.

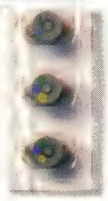


Excellent power handling

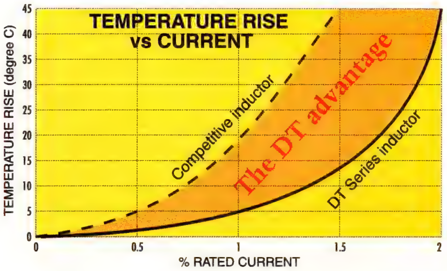
Our DT inductors solve thermal management problems. As you can see from the graph, even at 150% of rated current the temperature rise is less than 15°. You can use them at much higher currents because their construction provides a natural heat sink.

True surface mount design

All materials used in these inductors are optimized for surface mounting. There are no structural plastics or potting materials to be damaged by reflow soldering or cleaning operations. Their flat top and standard tape and reel packaging permit easy auto insertion. And self-shielding characteristics are on a par with toroid designs.



Parts are packaged in tape and reel.



Free evaluation samples

Check out the size and performance advantages of these new DT Series inductors for yourself. Order our $95 Designer's Kit No. C104 with 3 each of 38 different parts. Or call **800/322-2645** for free samples of two values.

Coilcraft

eem/electronic engineers master See our catalog in Vol. A, Section 1800

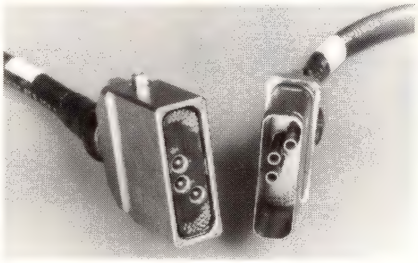
1102 Silver Lake Rd., Cary IL 60013 800/322-2645 Fax 708/639-1469

CIRCLE 188 FOR U.S. RESPONSE

CIRCLE 189 FOR RESPONSE OUTSIDE THE U.S.

▼ HIGH-VOLTAGE CONNECTOR DISCONNECTS QUICKLY

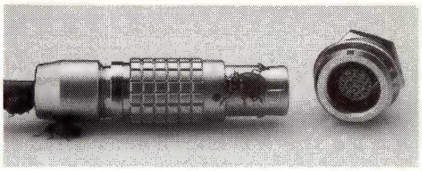
A quick-disconnect connector is designed for maximum safety for pilots using high-voltage, helmet-mounted CRT displays. The model 1180 connector relies on the company's Pulse-Guard material to completely eliminate all risk of electric-arc formation when the CRT's high-voltage circuits are separated during emergency disconnects. The connectors' high-voltage modules are rated for up to 15 kV and are fully sealed and isolated from the environment and other circuits. Call for pricing and delivery.



G&H Technology Inc.
750 W. Ventura Blvd.
Camarillo, CA 93010
(805) 484-0543
▶CIRCLE 812

▼ TINY CONNECTOR HITS MINIATURIZATION HIGH

Originally developed to meet a special customer request, a tiny circular connector from LEMO USA is one of its smallest connectors yet. The unit includes 14 gold-plated, 0.5-mm-diameter contacts in one housing that accommodates a 28 AWG cable. The connector's compact design makes it a candidate for applications requiring space savings with high contact density. A wide selection of shell styles are available ranging from in-line plugs and receptacles to an array of panel-mounted receptacles. Pricing for a standard mated pair is about $46 in quantities of 100. Delivery is from stock to 16 weeks.



LEMO USA Inc.
P.O. Box 11488
Santa Rosa, CA 95406
(800) 444-5366
▶CIRCLE 813

POWER-SOURCE MANUFACTURERS

Reich Associates Inc.
Route 4, Box 4620
Lakehills, TX 78063
(210) 751-3220
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (MD) (PF) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MI) (50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (ML)
CIRCLE 729

Reliability Inc.
Power Products Div.
P.O. Box 218370
Houston, TX 77218
(713) 492-0550
(50C) (DC) (SW)
CIRCLE 730

Renata Batteries U.S.
990 N. Bowser Rd., Suite 900
Richardson, TX 75081
(214) 234-8091
(AL) (LT) (ME) (SO) (ZA)
CIRCLE 731

Resonant Power Technology Inc.
1926 Junction Ave.
San Jose, CA 95131-2102
(408) 441-0800
(50S) (51S) (11S) (200S) (OF) (CV) (MD) (PF)
CIRCLE 732

SGS-Thomson Microelectronics
55 Old Bedford Rd.
Lincoln, MA 01773
(617) 259-0300
(50C) (DC) (50R) (LI) (SW) (ID) (BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 733

Sager
60 Research Rd.
Hingham, MA 02043
(800) 724-3780
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (DC) (AC) (MO) (IC) (50R) (10R) (11R) (200R) (LI) (SW) (MU) (ID) (AL) (CZ) (LT) (NC) (SO) (ZA) (ZC) (MF) (RE) (TH) (PI) (PC)
CIRCLE 734

Samsung Semiconductor Inc.
3655 N. First St.
San Jose, CA 95134
(408) 954-7229
(50R) (10R) (ID) (BT) (MF) (PI) (PC)
CIRCLE 735

Sanyo Energy (U.S.A.) Corp.
2001 Sanyo Ave.
San Diego, CA 92173
(619) 661-6620
(AL) (LT) (NC) (NM)
CIRCLE 736

Schaefer Inc.
200 Butterfield Dr.
Ashland, MA 01721
(508) 879-8658
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CIRCLE 737

Semiconductor Circuits Inc.
Sub. of Astec
49 Range Rd.
Windham, NH 03087
(603) 893-2330
(50C) (10C) (11C) (DC)
CIRCLE 738

Semtech Corp.
652 Mitchell Rd.
Newbury Park, CA 91320
(805) 498-2111
(50C) (10C) (11C) (200C) (DC) (AC) (MO) (IC) (50R) (10R) (11R) (LI) (SW) (MU) (ID) (ML) (BT) (RE) (PI) (PC)
CIRCLE 739

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
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CIRCLE 740

Siemens Corp.
Siemens Components Inc.
10950 North Tantau Ave.
Cupertino, CA 95014
(408) 777-4542
(MF) (PI)
CIRCLE 741

Sierra West Power Systems
2615 Missouri Ave., Bldg. 5
Las Cruces, NM 88001
(505) 522-8828
(50S) (51S) (500S) (10S) (11S) (200S) (RM) (OF) (CV) (RP) (MD) (UN) (PF) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO) (IC) (MI) (50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 742

Silicon Transistor Corp.
27 Katrina Rd.
Chelmsford, MA 01824
(508) 256-3321
(BT) (MF) (RE) (TH)
CIRCLE 743

Siliconix
2201 Laurelwood Rd.
Santa Clara, CA 95056
(800) 554-5565
(MF) (PI)
CIRCLE 744

Sola Electric
1717 Busse Rd.
Elk Grove Village, IL 60007
(708) 439-2800
(50S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (PR) (UN) (LI) (SW)
CIRCLE 745

Sorensen Co.
615 N. Railroad Ave.
Paxton, IL 60957
(217) 379-2171
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (CV) (RP) (PF) (50C) (200C) (DC) (MO)
CIRCLE 746

Stanford Research Systems
1290-D Reamwood Ave.
Sunnyvale, CA 94089
(408) 744-9040
(500S) (LA) (RM) (CV) (RP)
CIRCLE 747

Supertex Inc.
1350 Bordeaux Dr.
Sunnyvale, CA 94089
(408) 744-0100
(MF) (PI) (PC)
CIRCLE 748

Switching Systems International
500 Porter Way
Placentia, CA 92670
(714) 996-0909
(50S) (11S) (200S) (OF) (PF) (50C) (11C) (DC) (50R) (11R) (200R) (SW)
CIRCLE 749

Taltronics Corp.
Div. of Dimetrics Inc.
404 Armour St., P.O. Box 339
Davidson, NC 28036
(704) 892-8872
(50S) (51S) (11S) (200S) (RM) (OF) (CV) (PF) (50C) (11C) (200C) (DC) (MO)
CIRCLE 750

Tamura Corp. of America
P.O. Box 892230
Temecula, CA 92589-2230
(909) 699-1270
(50S) (11S) (200S) (OF) (50C) (500C) (10C) (DC) (AC) (50R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 751

Tauber Electronics Inc.
4901 Morena Blvd., Suite 314
San Diego, CA 92117
(619) 274-7242
(UN) (AL) (CZ) (LC) (LT) (ME) (NC) (NH) (NM) (SO) (ZA) (ZC)
CIRCLE 752

Tecnetics
6287 Arapahoe Ave.
Boulder, CO 80303
(303) 442-3837
(50S) (51S) (500S) (10S) (11S) (200S) (MD) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (MO) (IC) (MI) (50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 753

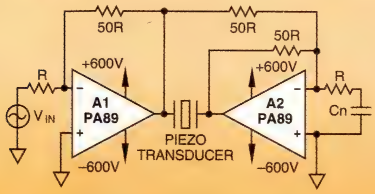
Telcom Semiconductor
1300 Terra Bella Ave.
Mountain View, CA 94039
(415) 968-9251
(IC) (ID) (PI) (PC)
CIRCLE 754

(see p. 110 for key)
(continued on p. 110)

Apex Microtechnology has more than 25 models of high voltage operational amplifiers. Voltage supplies range from ±75V up to ±600V. Both the PA88 and PA85 outlined below are available in a military version. This means the parts are tested over the full military case temperature range of –55°C to +125°C. Apex Applications Engineers can answer your specific applications and product selection questions. Call toll free **1-800-862-1021**. Or FAX **1-602-888-3329**.

PA89
Industry's Highest Voltage

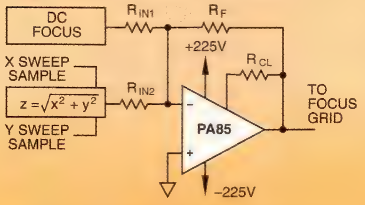
- ±600V supply
- 75mA output
- 3kHz power bandwidth
- 6.0mA max quiescent current
- Input Offset Voltage 2mV max



±1100V SINGLE AXIS MICRO-POSITIONING

PA85/PA85M—High Voltage, High Power Bandwidth

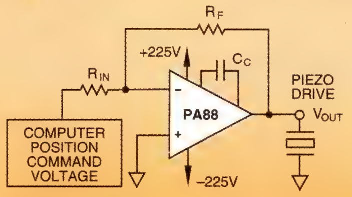
- ±225V supply
- 200mA output
- 550kHz power bandwidth
- 1000V/µs
- High reliability, military version



HIGH VOLTAGE DYNAMIC FOCUSING

PA88/PA88M—High Voltage, Low Quiescent Current

- ±225V supply
- 100mA output
- 2.0mA max quiescent current
- Programmable current limit
- High reliability, military version



±210V LOW POWER, PIEZOELECTRIC POSITIONING

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or to Place an Order
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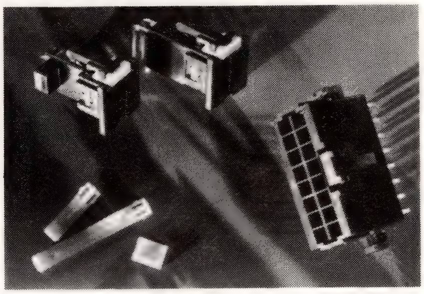
***AUSTRALIA, NEW ZEALAND** (08) 277 3288 **BELGIUM/LUXEMBOURG** (03) 458 3003 **CANADA** (613) 592 9540 **DAEHAN MINKUK** (02) 745 2761 **DANMARK** (45) 97 25 0816 **DEUTSCHLAND** (6172) 72030 **ESPAÑA** (1) 530 4121 **FRANCE** (1) 69 07 08 24 **HONG KONG** 8339013 **INDIA** (212) 339836 **ISRAEL** (3) 9345171 **ITALIA** (2) 99041977 **NEDERLAND** (10) 451 9533 **NIPPON** (3) 3244-3787 **NORGE** (2) 50 06 50 **ÖSTERREICH** (222) 505 15 220 **PEOPLES REPUBLIC OF CHINA** (86) 500 7788 **REPUBLIC OF SOUTH AFRICA** (021) 24-4071 **SCHWEIZ** (6172) 72030 **SINGAPORE** (65) 741 8966 **SUOMI** (0) 522 122 **SVERIGE** (8) 795 9650 **TAIWAN—REPUBLIC OF CHINA** (02) 722 3570 **TURKIYE** (1) 337 22 45 **UNITED KINGDOM** (844) 278781*

CIRCLE 84 FOR U.S. RESPONSE **CIRCLE 85 FOR RESPONSE OUTSIDE THE U.S.**

▼ LOCKING CONNECTOR ASSURES MATING

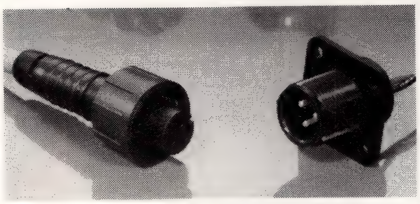


A secondary lock that helps ensure terminal positioning is a benefit of the Mini-Fit TPA high-current, high-power-density connector system. Available in wire-to-wire and wire-to-board versions, the system has a highly visible terminal-position-assurance (TPA) key that's easy to insert into the housing once the crimped terminals are fully inserted. Available in from two to 16 circuits, the Mini-Fit TPA system can handle standard equipment-I/O currents despite its small size. For example, the two-circuit pc-board connector can handle up to 9 A per circuit at 600 V. Pricing depends on circuit size, configuration, and volume.

Molex Inc.
2222 Wellington Ct.
Lisle, IL 60532
(708) 969-4550
▶CIRCLE 814

▼ TOUGH NYLON CONNECTORS MATE WITH METAL TYPES

A plastic 5015-connector series is designed and manufactured to intermate with MIL-C-5015 aluminum connectors. The tough nylon units withstand harsh environments and have exceptional impact and corrosion resistance coupled with liquid-tight sealing capabilities. The devices comply with UL, CSA, and NEMA standards. They're also available in other materials for specific applications. Call for pricing and delivery.



Technical Components Co. Inc.
6633 W. 99th St.
Chicago Ridge, IL 60145
(708) 424-1900
▶CIRCLE 815

POWER-SOURCE MANUFACTURERS

Todd Products Corp.
50 Emjay Blvd.
Brentwood, NY 11717-4905
(516) 231-3366
(50S) (11S) (200S) (RM) (OF) (CV) (RP) (UN) (PF) (50C) (11C) (200C) (DC) (MO) (50R) (11R) (200R)
CIRCLE 755

Toko America Inc.
1250 Feehanville Dr.
Mount Prospect, IL 60056
(708) 297-0070
(50S) (10S) (11S) (200S) (OF) (CV) (PF) (50C) (10C) (DC) (AC) (LI) (SW) (PC)
CIRCLE 756

Total Power International Inc.
418 Bridge St.
Lowell, MA 01850
(508) 453-7272
(50S) (10S) (11S) (200S) (OF) (50C) (10C) (11C) (200C) (DC) (MO) (IC) (50R) (10R) (11R) (LI) (SW) (MU)
CIRCLE 757

Transistor Devices Inc.
85 Horsehill Rd.
Cedar Knolls, NJ 07927
(201) 267-1900
(50S) (51S) (500S) (11S) (200S) (LA) (RM) (CV) (PR) (RP) (MD) (UN) (PF) (50C) (51C) (500C) (11C) (200C) (DC) (AC) (MO) (MI) (51R) (500R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 758

Tri Source Inc.
415 Howe Ave.
Shelton, CT 06484
(203) 924-7030
(50S) (51S) (10S) (11S) (200S) (RM) (OF) (CV) (RP) (MD) (UN) (PF) (50C) (51C) (11C) (200C) (DC) (MI) (50R) (51R) (11R) (200R) (LI) (SW) (ML)
CIRCLE 759

Tri-Mag Inc.
1601 N. Clancy Ct.
Visalia, CA 93291
(209) 651-2222
(50S) (51S) (10S) (11S) (200S) (OF) (UN) (PF) (50C) (51C) (10C) (11C) (DC) (AC) (MO) (50R) (10R) (11R) (SW) (MU)
CIRCLE 760

Tripp Lite
500 N. Orleans
Chicago, IL 60610-4188
(312) 329-1601
(50S) (200S) (PR) (UN) (51C) (AC) (200R)
CIRCLE 761

Ultralife Batteries Inc.
1350 Route 88 S.
Newark, NY 14513
(800) 332-5000
(LT)
CIRCLE 762

Unipower Corp.
3900 Coral Ridge Dr.
Coral Springs, FL 33065
(305) 346-2442
(50S) (200S) (RM) (OF) (UN) (PF) (50C) (200C) (DC)
CIRCLE 763

Valor Electronics Inc.
9715 Business Park Ave.
San Diego, CA 92131-1642
(619) 537-2500
(50C) (10C) (DC)
CIRCLE 764

Varta Batteries Inc.
OEM Div.
300 Executive Blvd.
Elmsford, NY 10523
(914) 592-2500
(AL) (LC) (LT) (ME) (NC) (NM) (SO) (ZA)
CIRCLE 765

Vicor Corp.
23 Frontage Rd.
Andover, MA 01810
(508) 470-2900
(50S) (51S) (CV) (MD) (PF) (50C) (51C) (DC) (MO) (MI)
CIRCLE 766

Viking Industrial Products
729 Farm Rd.
Marlboro, MA 01752
(508) 481-4600
(50S) (51S) (10S) (11S) (200S) (OF) (CV) (PR) (50C) (51C) (10C) (11C) (200C) (DC) (AC) (50R) (51R) (11R) (200R) (LI) (SW)
CIRCLE 767

Voltex Co. Inc.
3460 Great Neck Rd.
Amityville, NY 11701
(516) 842-2772
(50S) (51S) (10S) (11S) (200) (RM) (OF) (CV) (RP) (PF) (50C) (51C) (10C) (11C) (200C) (DC) (MO) (50R) (51R) (10R) (11R) (200R) (SW) (MU)
CIRCLE 768

Wall Industries Inc.
5 Watson Brook Rd.
Exeter, NH 03833
(603) 778-2300
(50S) (10S) (11S) (200S) (RM) (OF) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (MO)
CIRCLE 769

Wayne Kerr/Farnell
11 Sixth Rd.
Woburn, MA 01801
(617) 938-8390
(50S) (51S) (11S) (200S)
CIRCLE 770

Wilson Greatbatch Ltd.
Electrochem Battery Div.
10000 Wehrle Dr.
Clarence, NY 14031
(716) 759-6901
(LT)
CIRCLE 771

Xentek Inc.
1770 La Costa Meadows Dr.
San Marcos, CA 92069
(619) 471-4001
(50S) (RM) (OF) (CV) (MD) (PF) (50C) (10C) (11C) (200C) (DC) (MO) (IC) (50R) (200R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 772

Yuasa-Exide Inc.
Stationary Battery Div.
P.O. Box 14145
Reading, PA 19612-4145
(215) 378-0333
(LC) (NM)
CIRCLE 773

Zenith Electronics Corp.
Zenith Power Supplies
1000 Milwaukee Ave.
Glenview, IL 60025-2493
(708) 391-8510
(50S) (51S) (11S) (200S) (LA) (OF) (PF)
CIRCLE 774

KEY

Power Supplies

Output

(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs
(UN)	Uninterruptible
(PF)	Power-factor-corrected

Power Converters

Output

(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

(DC)	Dc to dc
(AC)	Dc to ac
(AT)	Ac to dc
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs

Power Regulators

Output

(50R)	To 50 V
(51R)	51 to 500 V
(500R)	Over 500 V
(10R)	To 10 W
(11R)	11 to 200 W
(200R)	Over 200 W

Types

(LI)	Linear
(SW)	Switching
(MU)	Modular
(ID)	IC DIP
(ML)	Military designs

Batteries

Output

(AL)	Alkaline
(CZ)	Carbon zinc
(LC)	Lead acid
(LT)	Lithium
(ME)	Mercury
(NC)	Nickel cadmium
(NH)	Nickel hydrogen
(NM)	Nickel metal hydride
(SO)	Silver oxide
(ZA)	Zinc air
(ZC)	Zinc chloride

Power Semiconductors

Output

(BT)	Bipolar transistors
(MF)	MOSFETs
(RE)	Rectifiers
(TH)	Thyristors
(PI)	Power ICs
(PC)	Power-control ICs

Why just give a present, when someone special to you celebrates a birthday, wedding, the birth of a child, the holidays or any other special day? Instead, give a gift that's as special as the day itself — a U.S. Savings Bond. After all, **when you can give** someone a piece of the future, you show you care today — and tomorrow. Get U.S. Savings Bonds at your bank, and be sure to ask for a U.S. Savings Bond gift certificate. Then, when someone special to you celebrates a special day, give U.S. Savings Bonds. You'll give **a piece of the future.**

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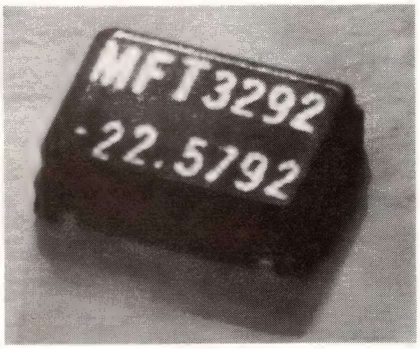
A public service of this magazine

▼ TINY OSCILLATORS DRIVE FULL-SIZE LOADS

Two types of micro-miniature, surface-mounted clock oscillators are each capable of driving 50-pF or 10-TTL loads over a frequency range of 1.8 MHz through 66.7 MHz. The oscillators measure 5 by 7 mm with a height of 2.3 mm. The T1280 and T1282 fixed-frequency versions offer frequency stabilities of 0.01% and 0.005%, respectively. The T3290 and T3292 tri-state versions boast the same stabilities, respectively, plus a threshold of 1.5 V, making them compatible with TTL disabling. Pricing is \$4.25 in lots of 1000. Delivery is in eight to 10 weeks.



MF Electronics Corp.
10 Commerce Dr.
New Rochelle, NY 10801
(914) 576-6570
▶ CIRCLE 820

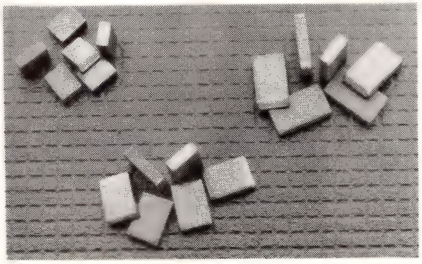
▼ LOW-VOLTAGE EL LAMP HOLDS DOWN POWER DRAW

Thanks to new process technology and an ultra-small inverter, a low-voltage electroluminescent (EL) lamp offers lower power operation than previous generations at an economical cost. The Series LV EL foil lamp will operate at 30 V ac or less, which means that the inverter's coil can be significantly smaller. As a result, the inverter measures just 0.35 by 0.6 by 0.7 in., which is almost three times smaller than the smallest older models. The total power consumption for lamp and inverter is typically under 20 mA for a 4 in.^{2} lamp. In most applications, the cost for both is under \$10. Lamps are typically custom made and delivered in eight weeks after receipt of order.

ELtech
181 Gibraltar Rd.
Horsham, PA 19044
(215) 441-0404
▶ CIRCLE 821

▼ CERAMIC-CHIP CAPS IN LARGER VALUES

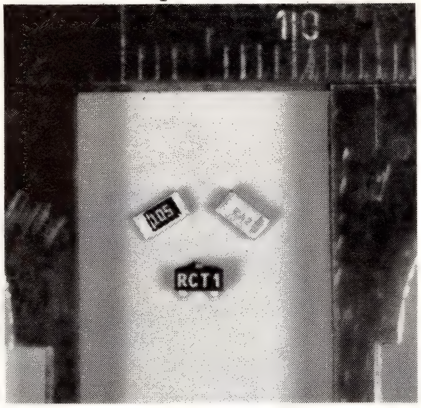
Additional capacitances have been added to the MCS Series of ceramic-chip capacitors. Larger versions now offer values from 10,000 pF to 6.8 million pF. These devices feature terminations fashioned using a dry-film process that overcomes several problems associated with conventional plated terminations. The process eliminates the need to immerse the chips in plating solutions, which can deposit conductive ions on the ceramic that cause insulation resistance failures. Pricing is from \$0.018 to \$0.67 in lots of 10,000. Delivery is from stock to 10 weeks.



ROHM Corp.
3034 Owen Dr.
Antioch, TN 37013
(615) 641-2020
▶ CIRCLE 822

▼ RC NETWORK COMES IN SOT-23 PACKAGE

A surface-mounted resistor-capacitor network is available in an SOT-23 package. Particularly useful for reducing crosstalk in high-speed applications, the PRC207 Series network regionalizes networking by replacing multiple discretes, cutting component counts by 50%, and using 70% less board space than traditional components. Used as low-pass filters, the networks reduce the emission of EMI and RFI by filtering out the high-frequency content of digital signals at the board level. They're operable at frequencies as high as 1 GHz. Pricing is \$0.20 in lots of 10,000. Delivery is in six weeks.



California Micro Devices Corp.
215 Topaz St.
Milpitas, CA 95035-5430
(408) 263-3214
▶ CIRCLE 823

▼ CHIP RESISTORS RANGE TO 1000 GΩ

A family of gigohm thick-film chip resistors offers values of up to 1000 GΩ. The HC-C-0805 resistors measure 0.078 by 0.050 in. and feature exceptionally tough platinum silver, solder-coated wraparound terminations for all soldering applications. Versions are also available without solder for other bonding methods such as conductive epoxy or wire bonding. The chips' high resistance values are achieved with standard thick-film materials and a newly developed screening method. Delivery is from stock to three weeks. Call for pricing.

International Mfg. Services Inc.
50 Schoolhouse Ln.
Portsmouth, RI 02871-2418
(401) 683-9700
▶ CIRCLE 824

▼ MOLDED SMT RESISTOR STAYS STABLE

Outstanding performance similar to that of the company's S102 through-hole product is offered by the SMR3 precision-molded surface-mounted resistor. Use of Vishay's Bulk Metal Foil resistive element results in a very low temperature coefficient of resistance and long-term stability of 0.005% for 2000 hours. Other features include excellent moisture resistance, tight tolerances of 0.01%, and low-noise operation. Values range from 5 Ω to 80 kΩ. Call for pricing and delivery.

Vishay Resistors
63 Lincoln Hwy.
Malvern, PA 19355
(215) 640-9081
▶ CIRCLE 825

As fast as a phone call. McKenzie Technology has the answer to all your socket and board to board interconnection needs.

McKenzie Technology offers the widest selection of molded PGA footprints and contact options in the business, and the only family of sockets designed specifically for the latest high speed integrated circuits. All McKenzie Technology sockets are designed, tooled, and manufactured in-house to guarantee the highest quality available anywhere.

Downsized board configurations require more efficient, more reliable, higher density interconnect systems. McKenzie Technology delivers solutions like 2mm thru hole and SMT header systems, and Interstitial PGA sockets.

McKenzie is the universal source for your interconnection requirements...DIP, SIP, ZIP, PGA, PLCC sockets, adaptors, surface mount, two piece connector systems. A single source, just a phone call away.

Committed to customer satisfaction worldwide.

Service: In-house engineering and manufacturing deliver prompt design, tooling and molding solutions.

Quality: Dock-to-stock certified with customers around the globe.

Quick Turnaround: Samples in 48 hours. Shortest lead times on standard products in the industry.

Competitive Pricing: You bet!

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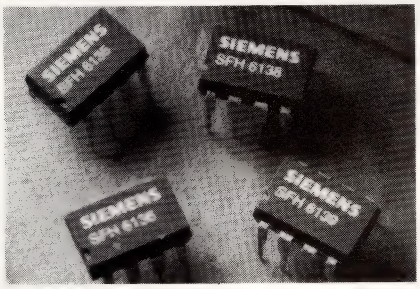
CIRCLE 218 FOR U.S. RESPONSE

CIRCLE 219 FOR RESPONSE OUTSIDE THE U.S.

▼ FAST OPTOCOUPLERS FIT PORTABLE TASKS

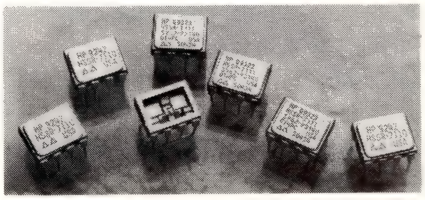
The industry's fastest high-gain optocouplers specifically developed for portable applications are the SFH 6138 and 6139. The devices offer a 5-μs switching time that's 40 times faster than competing products. In addition, two phototransistor optocouplers are available for high-speed standard applications. The SFH6136 offers a switching time of 0.8 μs, while the SFH6135 is also extremely fast at 0.1 μs. All four are approved by UL and VDE for use in consumer electronics. Pricing in lots of 10,000 is $1.01 for the 6135, $1.10 for the 6136, $0.85 for the 6138, and $0.97 for the 6139. All are available from stock.



Siemens Components Inc.
19000 Homestead Rd.
Cupertino, CA 95014
(800) 777-4363, ext. 411
▶ **CIRCLE 826**

▼ MIL-SPEC SWITCH REPLACES RELAYS

A high-reliability, optically isolated switch offers a MIL-qualified alternative to standard 1 Form A electromechanical and solid-state relays used in military and aerospace applications. The HSSR-7111/DESC 5962-93314001HPC is the qualified version of HP's HSSR-7110 commercial power-MOSFET optocoupler. It operates as a solid-state, SPST, normally open relay and comes in a hermetic 8-pin DIP. Applications include power control in aircraft, ships, and tactical vehicles; and power or signal switching within military communication, radar, or electronic-warfare equipment. The unit features a 1.6-A steady-state-current rating and a 10-A surge-withstanding capability in the dc-connection mode with an R_{ON} of 0.25 Ω. Pricing is $72 in lots of 1000. Delivery is from stock.



Hewlett-Packard Co.
P.O. Box 58059
Santa Clara, CA 95052-8059
(800) 227-1817, ext. 7634
▶ **CIRCLE 827**

▼ LIGHTED PUSHBUTTON IS SEALED TIGHT

Two internal seals protect the contact mechanisms of the LB and YB Series panel-mounted lighted pushbutton switches. The seals guard against intrusion by oil and water splashes, airborne dust, and other contaminants. A third external O-ring seal prevents splashes from entering the panel. The switches come in SPDT and DPDT circuits and with current ratings of 3 A at 125/250 V ac or 0.4 VA maximum at 28 V ac/dc for logic-level applications. Panel cutouts of 22 mm are required for industry-standard mounting of the LB switches, while the YB switches fit into 16-mm cutouts. Call for pricing and delivery.

NKK Switches
7850 E. Gelding Dr.
Scottsdale, AZ 85260
(602) 991-0942
▶ **CIRCLE 828**

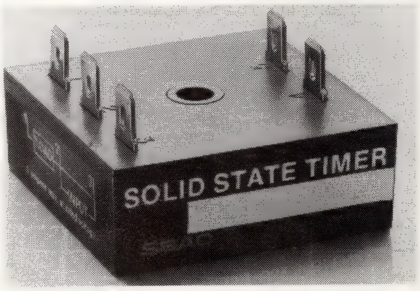
▼ ROUND PUSHBUTTONS SHUT OUT OIL, WATER

Round pushbuttons have been added to the oil- and water-tight Series 61 modular switching system. The switches are available as a 25-mm recess-mounted type and with an aluminum front ring and mushroom cap. Engineered for industrial and process-control applications, the Series 61 switches meet IP 65 and NEMA 4 and 13 specifications. The 16-mm devices can be mounted on pc boards regardless of the number of poles (1, 2, or 3) or switching action. With ratings of 6 A and 250 V ac, the switches mount in a 5/8-in. round hole. Delivery is from stock to four weeks after receipt of order. Call for pricing information.

EAO Switch Corp.
198 Pepe's Farm Rd.
Milford, CT 06460
(203) 877-4577
▶ **CIRCLE 829**

▼ SOLID-STATE TIMERS OFFER VERSATILITY

All modes of operation, including delay on make, delay on break, interval, and single-shot are available in the Versa-Timer series of solid-state timing modules. The TS Series devices offer fixed or adjustable time delays from 0.05 to 600 seconds in four standard ranges. The devices' analog circuitry is fully encapsulated in a molded 2-by-2-by-3/4-in. housing with 1/4-in. quick-connect terminals. Operating voltages of 24, 120, or 230 V ac are available on all models. Some are available with operating voltages of 12. 24, or 120 V dc. OEM pricing is under $7 in high volume. Delivery is from stock.



SSAC Inc.
P.O. Box 1000
Baldwinsville, NY 13027
(315) 638-1300
▶ **CIRCLE 830**

▼ POWER RELAY SWITCHES 270 V DC AT 5 A

A 270-V dc, 5-A power-switching relay is available for multiple applications in the military, space, and commercial aerospace industries. The AP5 relay's 1.25 $in.^3$ size and high reliability is the result of Kilovac's vacuum-switching technology. Unlike most air-filled and solid-state relays, the AP5 relay is lightweight and space-efficient with over 2000 V of isolation across open contacts for safety. Single-pole, single-throw models are offered in normally open (AP5A) and normally closed (AP5B) configurations. Pricing for the AP5A is $203 in lots of 100. Through March of 1994, Kilovac is offering first-time users a single sample at the 100-piece price. Delivery is from stock to four weeks.

Kilovac Corp.
P.O. Box 4422
Santa Barbara, CA 93140
(805) 684-4560
▶ **CIRCLE 831**

What a can of worms: impossible electronic and mechanical requirements, multiple vendors, looming deadlines. Make it easy. Throw the whole mess at us. We define quality as total customer satisfaction and maintain carefully controlled manufacturing systems to reduce lead times and costs on complete interconnect systems engineered for smaller and more precise electronic equipment. We're using conductors as small as 44 AWG. High-speed coaxes with up to 93% velocity of propagation. Terminations to standard industry connectors or to specially designed custom connectors, including one that allows conductors to be terminated at a density of over 500 contacts per square inch. And terminations on flex circuits with center line spacing smaller than 0.025″. That's today. Tomorrow? Just tell us what you're fishing for.

PRECISION INTERCONNECT
an AMP company

Precision Interconnect, 16640 S.W. 72nd Avenue, Portland, OR 97224 (503) 620-9400 Fax (503) 620-7131. Sales offices in U.S., Europe and Japan.

SOLUTIONS FOR YOUR MESSIEST PROBLEMS.

CIRCLE 236 FOR U.S. RESPONSE

CIRCLE 237 FOR RESPONSE OUTSIDE THE U.S.

▼ HEAT SINKS' TABS LOCK ONTO PC BOARDS

A self-locking tab that fastens heat sinks securely onto pc boards is now available. The Shur-Lock solderable tabs have a spring action that prevents the heat sink from leaning or lifting off during wave soldering. The tabs can replace other, more complex mounting hardware at lower cost. The tabs fit 0.093-in. holes and lock positively with an audible snap. They're available on stamped heat sinks for TO-220, TO-218, TO-247, and other semiconductor packages. Call for pricing and delivery.

Aavid Engineering Inc.
P.O. Box 400
Laconia, NH 03247
(603) 528-3400
▶ CIRCLE 832

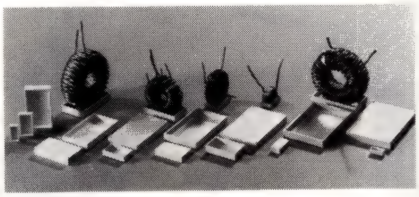
▼ EPOXY ADHESIVE PERFORMS IC BONDING

A one-component epoxy adhesive for chip bonding cures rapidly with exposure to heat. Loctite 3609 adhesive offers high thixotropic and deaerated properties and is well suited for drop-shape control and high-speed SMT dispensing equipment. A typical application is bonding of SMT devices to pc boards before wave soldering. The adhesive avoids slumping and stringing while providing a high dot profile with high green strength. Call for pricing and delivery.

Loctite Corp.
705 N. Mountain Rd.
Newington, CT 06111
(800) 562-0560
▶ CIRCLE 833

▼ PLATFORMS MOUNT TOROIDS VERTICALLY

A line of vertical-mount toroid platforms provides an economical, fast, and easy method of mounting toroids vertically to pc boards. Because there are no lead holes, the toroid's leads are not confined by the mount. Thus, they are free to terminate point-to-point. Or, the platforms can be customized by drilling holes for custom pc-board mounting. The platforms feature standoff feet to allow for solder-fillet formation and flush cleaning of solder-flux residues from beneath the assembly. Pricing is from $0.13 to $0.55, depending on size, in quantities of 1000.



Robison Electronics Inc.
P.O. Box 8121
San Luis Obispo, CA 93403
(805) 544-8000
▶ CIRCLE 834

▼ CIRCUIT CLEANER IS ENVIRONMENT-SAFE

"Cold" benchtop circuit cleaning and degreasing combined with environmental safety are the keys to Axarel 2200, a DuPont-formulated cleaner with high strength and versatility.

Used with Micro Care's Trigger-Grip controlled dispensing system, the formulation can reduce cleanup costs by 40% or more on all types of circuits including hybrids, surface-mount stencils, and minute repair areas as well as mechanical parts. Pricing is from $9 to $12 per canister depending on quantity. Delivery is from distributor stock.

Micro Care Corp.
34 Ronzo Rd.
Bristol, CT 06010
(203) 585-7912
▶ CIRCLE 835

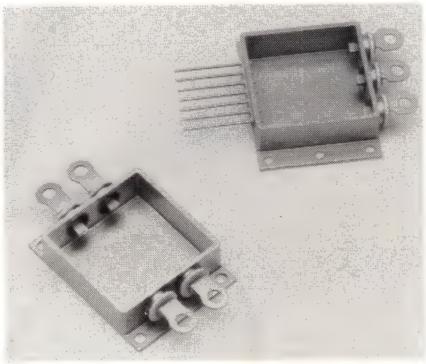
▼ FLEX MATERIALS NEED NO ADHESIVES

An adhesiveless material system for use in making multilayer and high-performance flexible printed circuits is available. The Flex-I-Mid 3000 system's materials offer excellent dimensional stability compared with traditional flexible material systems with adhesives, which makes for better execution of fine-line circuit designs. The absence of adhesive results in a lower coefficient of thermal expansion for improved reliability of plated-through-hole barrels in multilayer circuit designs. In addition, the materials allow for manufacture of flexible and rigid-flex circuits for reliable use at higher operating temperatures. The materials incorporate one or more polyimide-based dielectric layers (0.5 to 2 mils) with rolled copper foils (0.5 to 2 ozs). The materials are made by direct application of polyimide to the metal foil. Call for pricing and delivery.

Rogers Corp.
Circuit Materials Div.
100 N. Dobson Rd.
Chandler, AZ 85224
(602) 917-5270
▶ CIRCLE 836

▼ HERMETIC PACKAGES HANDLE HIGH POWER

The V-I-P line of standard and custom packages is a cost-effective solution that exceeds the requirements of today's largest and highest-power devices and circuits. High-temperature, brazed-ceramic feedthroughs with 0.100-in.-diameter C15715 pins provide a current rating of 100 A and breakdown voltages of more than 4 kV. Copper terminals provide for external connections using No. 6 or 8 screws. Standard designs are based on a 1.5-in.^{2} Kovar frame and 0.050-in.-thick, 2-by-1.5-in. copper-moly composite base. Call for pricing and delivery.



Ceradyne Inc.
3169 Redhill Ave.
Costa Mesa, CA 92626
(714) 549-0421
▶ CIRCLE 837

NEW LITERATURE

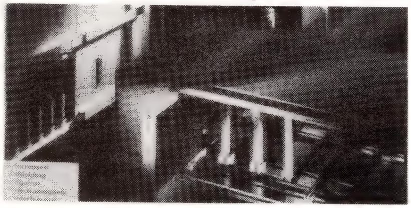
▼ HEAT DISSIPATORS KEEP SYSTEMS COOL

Thermal-management solutions for commercial, industrial, and military markets are detailed in the 1993 condensed catalog of heat-dissipation components. Included in the 20-page book are power-semiconductor heat sinks for TO-3 through TO-247 packages; heat sinks for ASICs, ICs, and MCMs; aluminum extrusions for power modules, IGBTs, SCRs, relays, panels, and cabinets; heat exchangers; liquid cold plates; and much more. Complete design capabilities and manufacturing operations are described.

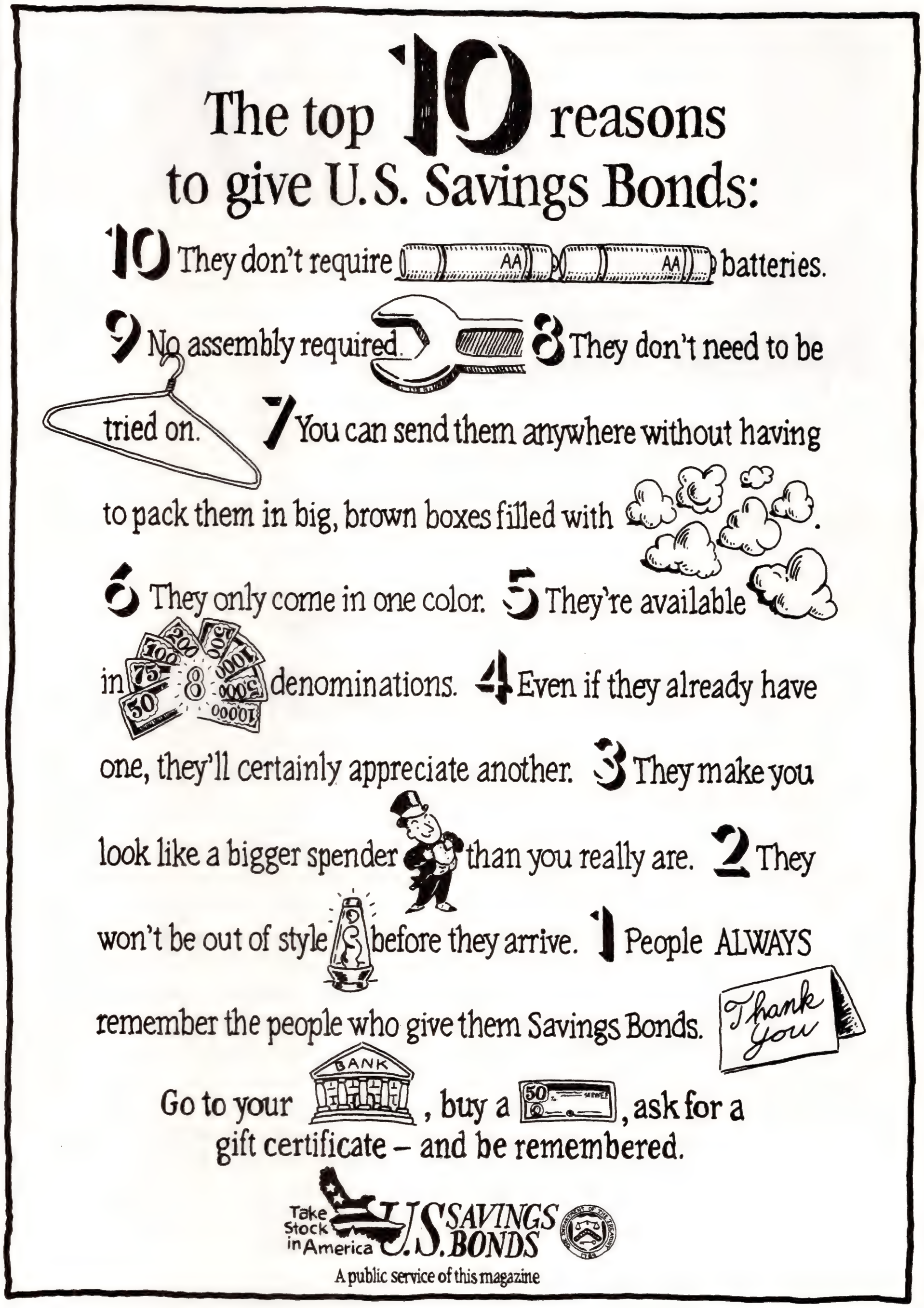
EG&G Wakefield Engineering
60 Audubon Rd.
Wakefield, MA 01880
(617) 245-5900
▶ CIRCLE 838

▼ EMC CASE BROCHURE DETAILS VARIETY

A design guide is available for the Ratiopac range of multi-functional system cases. The cases feature built-in EMC shielding and a versatile design for a wide variety of configurations. They can be used as either a portable desk-top case or mounted in a 19-in. rack. All external dimensions are identical to a 19-in. subrack for mounting standard bus-structured backplanes and plug-in units from the front or rear without additional accessories.



Schroff Inc.
170 Commerce Dr.
Warwick, RI 02886
(800) 451-8755
▶ CIRCLE 839



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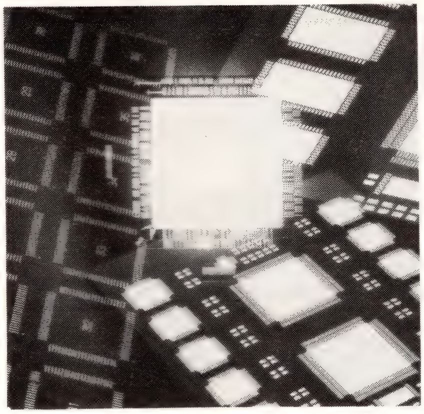
▼ MCM CAPABILITIES SHOWN IN BROCHURE

Capabilities for multichip modules in both ceramic technology (MCM-C) and ceramic with deposited thin-film dielectrics (MCM-D) are featured in a color brochure. Details of the technologies are provided as is a comparison of MCM materials including alumina, aluminum nitride, silicon carbide, mullite, low-temperature cofired ceramic, and low-epsilon ceramic. The brochure also contains standard MCM design guidelines and details of the company's MCM design, simulation, and subcontract-assembly capabilities.



Kyocera America Inc.
8611 Balboa Ave.
San Diego, CA 92123
(800) 468-2957
▶ CIRCLE 840

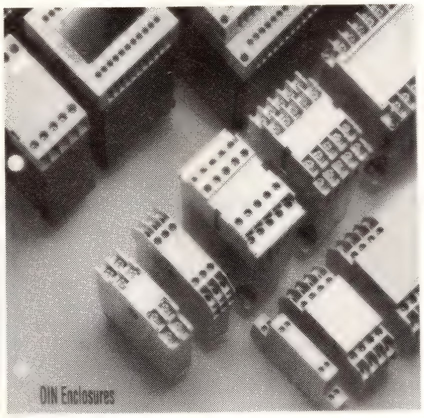
▼ TAPE PROBLEMS SOLVED IN 36-PAGE BROCHURE

A comprehensive 36-page catalog provides a quick technical reference to electrical and electronic tapes from eight leading manufacturers. The catalog features tapes for manufacturing and assembly as well as foil shielding and anti-static tapes. Information is provided on EIS's value-added fabrication and slitting capabilities.

Electrical Insulation Suppliers Inc.
300 N. Mannheim Rd.
Hillside, IL 60162
(708) 547-5400
▶ CIRCLE 841

▼ DIN ENCLOSURES HOUSE VARIOUS SYSTEMS

A 20-page, full-color catalog introduces over 50 basic DIN rail-mount electronic enclosures. The catalog provides design features, technical data, and ordering information. The versatile, non-metallic housings are available easy-to-assemble kits that feature from four to 144 integral, ready-to-wire terminals. Enclosures are rated for 300 V and up to 25 A and 12 AWG. They're well suited for housing devices such as relays, timers, transducers, sensing and monitoring devices, pc boards, and more.



Altech Corp.
35 Royal Rd.
Flemington, NJ 08822-6000
(908) 806-9400
▶ CIRCLE 842

▼ EMI SPRING GASKETS SEAL OFF ASSEMBLIES

A 16-page catalog describes a line of canted coil spring gaskets for EMI/RFI shielding. The catalog details the advantages of the concept and covers assembly techniques, materials, and compression forces. It also includes charts comparing shielding effectiveness at frequencies up to 100 GHz with a standard spring series. The gaskets are available in stainless steel and beryllium copper and may be plated as desired. They offer metal-to-metal contact with minimal apertures.

Bal Seal Engineering Co. Inc.
620 W. Warner Ave.
Santa Ana, CA 92707-3398
(714) 557-5192
▶ CIRCLE 843

▼ SOLDERING PRODUCTS WON'T HARM PLANET

A 20-page catalog details a full line of environmentally friendly soldering materials, specialty chemicals, and dispensing equipment. The catalog includes sections explaining materials parameters, such as the particle shape and size in the company's Delta solder pastes. Another section explains the viscosity of the pastes and how that parameter is measured. A selection guide aids in choosing the correct paste for a given application. Still other sections discuss solder reflow and how various processes relate to the company's broad line of fluxes. Four-color illustrations are used throughout.

Qualitek International Inc.
315 Fairbank St.
Addison, IL 60101
(708) 628-8083
▶ CIRCLE 844

▼ HIGH-TEMP MATERIALS INCLUDE ADHESIVES

Adhesives, ceramics, and other high-temperature materials are described in detail in Volume 92, Number 18 of Cotronics's handbook. A high-performance materials selector breaks out the product lines by temperature. Fourteen sections offer full descriptions of insulation products, high-temperature tapes and fabrics, machinable and castable ceramics, various cements and epoxies, potting materials, coatings, sealers, binders, putties, safety products, and more. A handy table outlines the physical properties of refractory, ceramic, and intermetallic materials.

Cotronics Corp.
3379 Shore Pkwy.
Brooklyn, NY 11235
(718) 646-7996
▶ CIRCLE 845

▼ ENGINEERING PLASTICS DESCRIBED IN FULL

A 22-page brochure offers full descriptions and full-color illustrations of a broad line of engineering plastics. Amoco Performance Products' wide array of plastics is covered. These include the company's Udel, Mindel, Radel A and R, Amodel, Xydar, Torlon, and Kadel resin brands. The brochure's text describes each in terms of mechanical, electrical, and chemical properties and outlines their agency approvals. Numerous color photographs detail the resins' applications in electronic systems and others.

Amoco Performance Products Inc.
4500 McGinnis Ferry Rd.
Alpharetta, GA 30202-3914
(800) 848-9744
▶ CIRCLE 846

vailable
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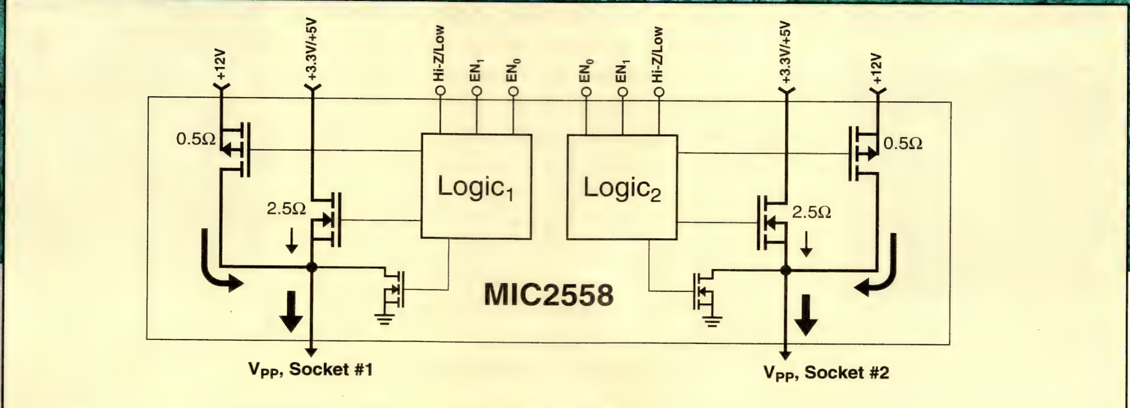
PCMCIA V_{PP} Switching Made Easy.



Low Power Consumption Monolithic Switch for V_{PP} Control

No External Components Needed

Now, Micrel solves your PCMCIA V_{PP} switching headaches with the easy-to-use MIC2558 PCMCIA V_{PP} switching matrix. An industry first, this device provides full PCMCIA Version 2 compatibility, switching all PCMCIA V_{PP} voltages for independent V_{PP1} and V_{PP2} pins. Alternatively, it drives two separate sockets. This dual switch, supplied in a small surface mount package, outputs two independent V_{PP} output voltages, typically selecting between 12V, or V_{CC} (5V or 3.3V), zero volts, or high impedance. Simply connect the MIC2558 to the power supply, PCMCIA controller, and card slots, and your PCMCIA power system design is complete. The MIC2558 replaces several discrete power components plus "glue" logic, and provides a low cost, small area, highly reliable solution. No external components are necessary.

Designed for Efficiency

With the MIC2558, you save money, design time, board space, and power — the MIC2558 is designed to draw mere nanoamperes under most circumstances. No need to switch the power to this power switch!

Micrel PCMCIA Switching Products	Availability
MIC2557BM Single V_{PP} Switch Matrix	Available Now
MIC2558BM Dual V_{PP} Switch Matrix	Available Now
MIC5014BM +2.75V to 5V V_{CC} FET Switch Driver	Available Now
MIC5016BM +2.75V to 5V Dual V_{CC} FET Switch Driver	Available Now

Designed for Compatibility

Designed to exceed PCMCIA specifications and recommendations, the MIC2558 outputs over 120mA of programming current. Its internal control logic operates from either 3.3V or 5V standard supplies (the control section is rated from 2.8V through 6V), and is logic compatible with industry standard PCMCIA controllers. For smaller systems, the MIC2557 single output switch supports one card slot.

Micrel Supports You

Complete applications support is available for all aspects of your PCMCIA power control implementation, including an informative booklet on PCMCIA power switching, industry standard controller interfacing, and zero OFF mode current consumption V_{PP} and V_{CC} control. Micrel is committed to remaining your choice for PCMCIA power control.

Call or FAX Micrel for complete details on this easy-to-use problem solver. MIC2557/2558 orders are shipped from stock. Micrel Semiconductor, 1849 Fortune Drive, San Jose, CA 95131.
Phone: (408) 944-0800, FAX: (408) 944-0970.

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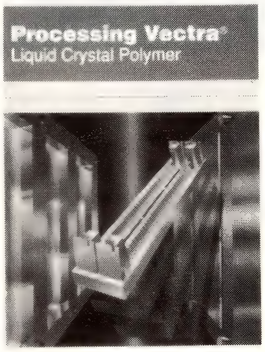
CIRCLE 216 FOR U.S. RESPONSE

CIRCLE 217 FOR RESPONSE OUTSIDE THE U.S.

PROCESSING GUIDE DEMYSTIFIES POLYMERS

Optimizing the molding and extrusion of Vectra liquid-crystal polymers is the subject of a processing and troubleshooting guide. Written for processors, tool builders, and parts designers, the guide contains summaries of start-up conditions for injection molding and extrusion. The material is particularly suited for SIMM sockets. Included are solutions to a wide range of common molding problems including burn marks, discoloration, flashing, jetting, short shots, sinks and voids, and more. Guidelines are offered for material selection and handling.



Hoechst Celanese Corp.
Information Center
114 Mayfield Ave.
Edison, NJ 08818-3053
(800) 235-2637
▶ **CIRCLE 847**

CUSTOM ENCLOSURES OFFER FLEXIBILITY

A 24-page brochure on custom enclosure design and fabrication details the possibilities available with the Widney 20/30 enclosure system. This pre-engineered system produces rigid frameworks using extruded aluminum members. Complex enclosure shapes can be achieved with a selection of over 50 different stock angled extrusions and matching corner castings. The heavily illustrated brochure contains drawings of all component types and is filled with ideas for their combinations. A full line of accessories such as panel latches, handles, hardware, doors, and hinges is also detailed.

Crystal Mark Inc.
Custom Enclosure Div.
1062 Fairview Dr.
Carson City, NV 89701
(800) 788-7521
▶ **CIRCLE 848**

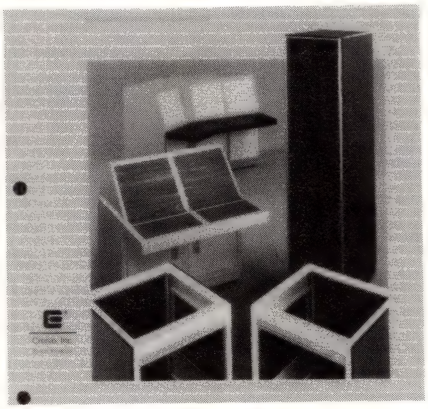
STATIC PROBLEMS SOLVED IN BROCHURE

Anyone in need of complete static protection will find the 24-page catalog from EIS to be helpful. The catalog describes the latest, state-of-the-art products for static control. Included is a complete line of workstation items including ionizers, wrist straps, monitors, static-test equipment, soldering equipment, floor and table mats, cleansers and chemicals, garments, and more. Profusely illustrated with photographs, the catalog contains capsulizations of the features of many products. The company also offers free static-control surveys of facilities that result in written recommendations for static-control measures.

Electrical Insulation Suppliers Inc.
300 N. Mannheim Rd.
Hillside, IL 60162
(708) 547-5400
▶ **CIRCLE 849**

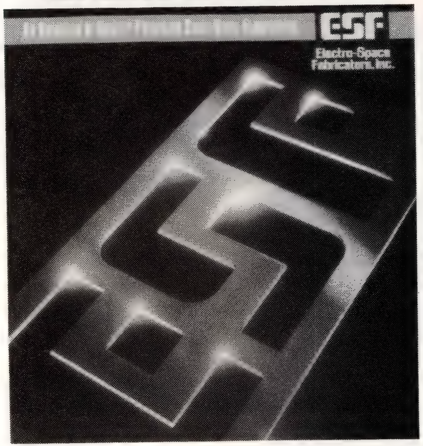
TWO ENCLOSURE LINES COVERED IN CATALOG

The ESQ and Emcor I modular enclosure systems are now presented in one easy-to-use, 72-page color catalog. New ESQ options include 30-in. panel-width frames and redesigned, lower-cost wedge units. The Emcor I family now offers 30-3/4-in.-deep frames and new window-door options. These fully modular systems cover unlimited console configurations and a large variety of accessories. The catalog summarizes options, features metric conversions, and includes diagrams.



Emcor Products
1600 4th Ave. N.W.
Rochester, MN 55901
(507) 289-3371
▶ **CIRCLE 850**

METAL-FAB SERVICES REVIEWED IN BROCHURE



A brochure is available with an overview of precision sheet-metal-fabrication services and highlighting product specialties, which include custom card enclosures, Euro subrack systems, packaging accessories, and injection-molded plastics. The full-color, 24-page brochure depicts a full range of capabilities and equipment. It also illustrates an array of finished products.

Electro-Space Fabricators Inc.
300 W. High St.
Topton, PA 19562-0067
(215) 682-7181
▶ **CIRCLE 851**

INTERFACE MATERIALS ATTACK THERMAL WOES

A 20-page brochure profiles the Cho-Therm family of thermal-interface materials. Included are thermally conductive insulators, mounting pads, adhesive tapes, comformable gap fillers, and potting compounds. In addition to details on the company's thermal pads, descriptions of new products include the Thermattach double-sided adhesive tapes, Cho-Therm T500 chiller-plate insulators, and ribbed forms of the Cho-Therm gap fillers. Configuration charts with dimensions and part numbers for all standard thermal pads are provided. A highly informative section offers a primer on heat-transfer fundamentals and how thermal-interface materials can help solve problems related to hot spots within systems.

Chomerics Inc.
77 Dragon Ct.
Woburn, MA 01888
(617) 935-4850
▶ **CIRCLE 852**

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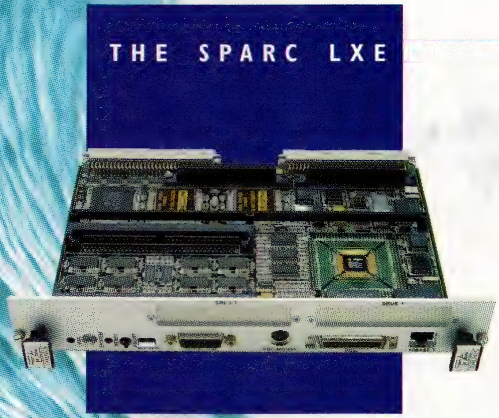

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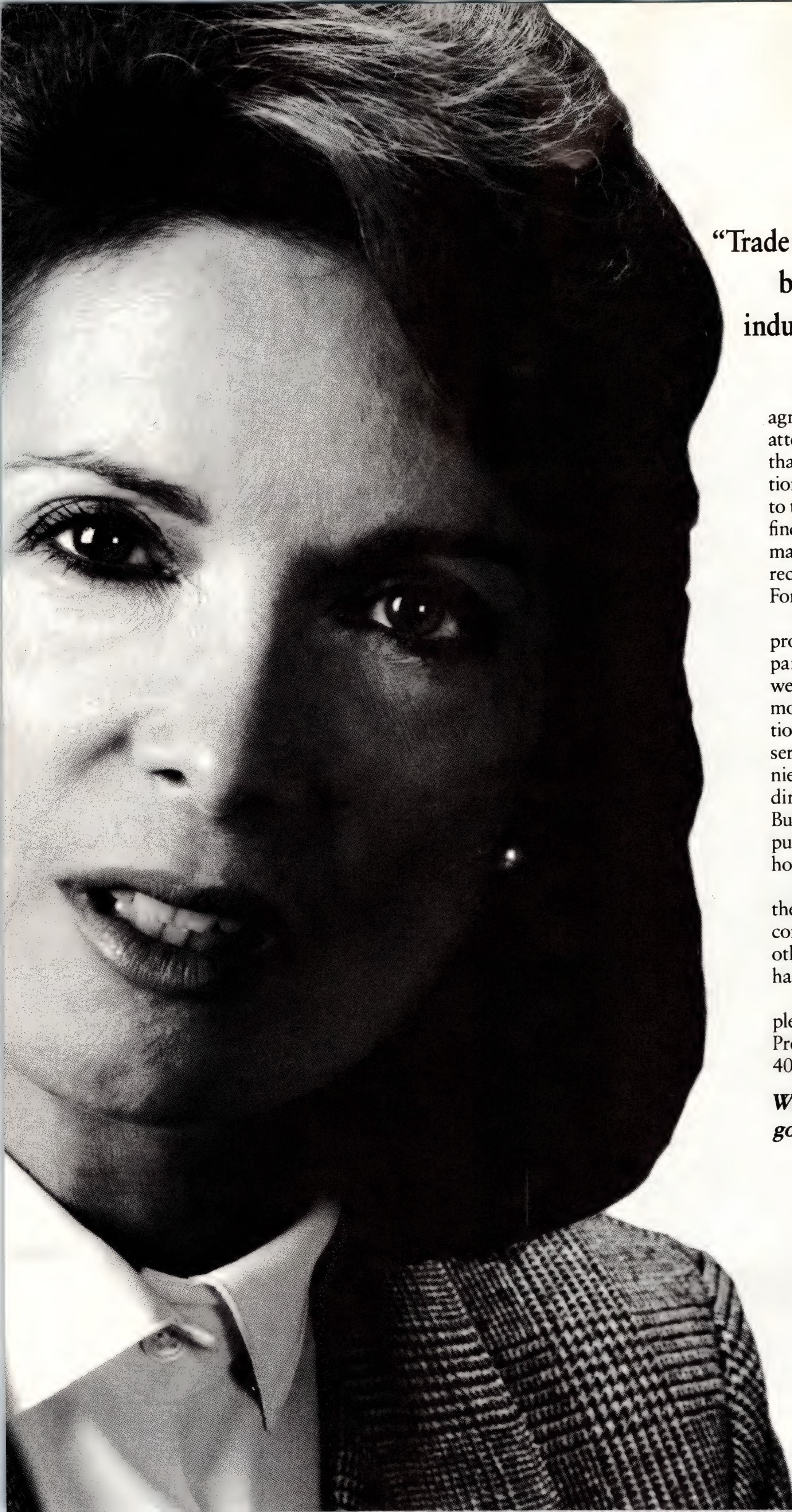

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Trade magazines are also at the top of the list when you consider cost per contact. No other medium is more efficient. Or has more credibility.

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CLEVER DESIGNS SPAWN 40-MHZ/10-BIT/0.2-W ADCS

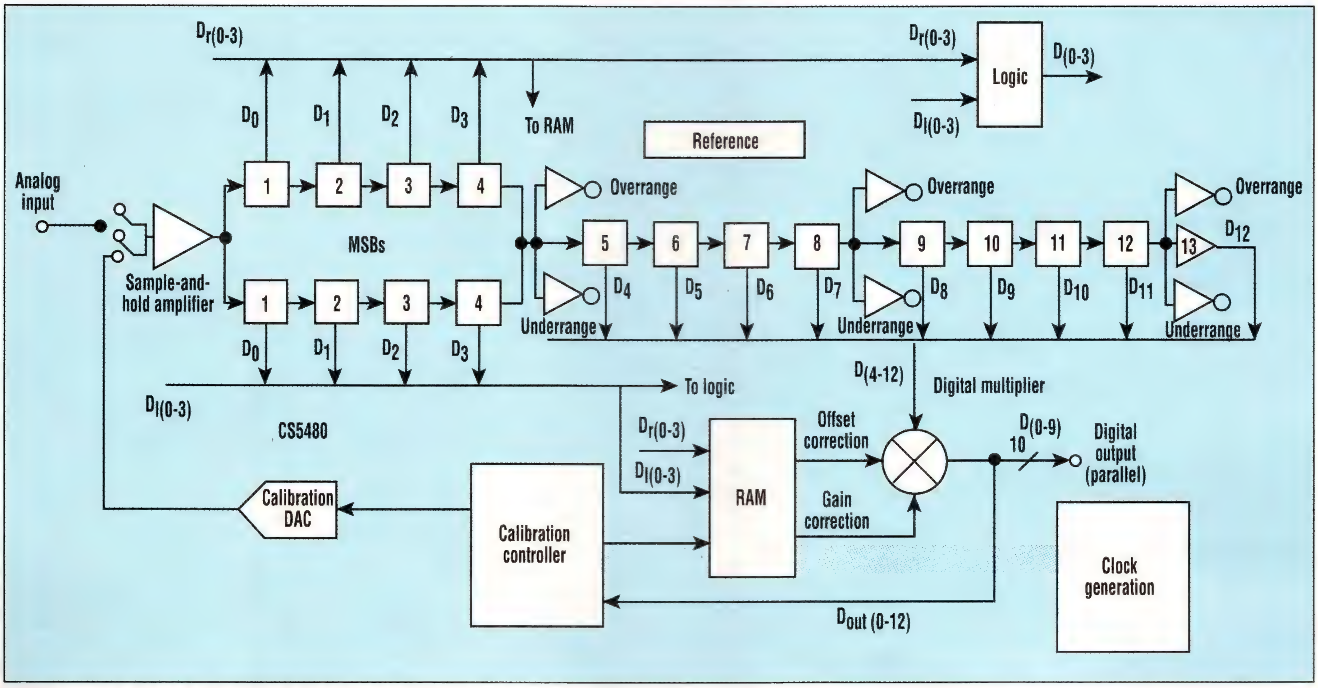
FINE-LINE CMOS PROCESS AND CREATIVE ARCHITECTURES DELIVER WIDEBAND-SAMPLING-RATE ADCS NEEDING JUST 75 TO 350 MW OF 5-V POWER.

FRANK GOODENOUGH

Unlike their digital-to-analog converter kin, which are totally dominated by just a few basic architectures, IC analog-to-digital converter designs are as varied as the imaginations of their designers. ADCs with 12 or more bits of resolution and sampling rates in excess of 1 MHz reflect this trend. Similarly, 10-bit ADCs, until recently rather slow and in little demand, are now beginning to follow suit.

Though 10-bit architectures have been dominated by simple CMOS successive-approximation-register (SAR) or two-step (half-flash) designs, a growing demand for higher-speed 10-bit devices has prompted a move to more uncommon architectures. However, until now, most advanced 10-bit ADCs still also employ two-step designs (ELECTRONIC DESIGN, *Apr. 1, 1993, p. 42).*

Now two companies, Crystal Semiconductor and Signal Processing Technologies (SPT), have developed "millipower" 10-bit, 40-MHz CMOS ADCs, each employing a novel architecture. While they share relatively similar



1. A PAIR OF 4-BIT PIPELINED ADCs, (blocks 1-4) operating in parallel in a "ping-pong" mode, generate the four most-significant bits (MSBs) for this Crystal Semiconductor CS5480 40-MHz, 10-bit ADC. The remaining six bits and three extra bits for digital calibration are generated by the single 9-stage pipelined ADC (blocks 5-13), which follows the four MSB stages.

specifications and combine 1-μm or finer-line CMOS processes with switched-capacitor analog circuitry, their only other common trait beyond that is a degree of parallelism.

Crystal's 40-MHz/10-bit CS5480, which typically needs just 375 mW of power from a 5-V rail (maximum power runs 500 mW), employs a 13-bit "pipelined" architecture. Its four most-significant bits (MSBs) are handled by two "pipelines" running in parallel *(Fig. 1)*. SPT's offering, actually a family of five 10-bit IC ADCs, uses an architecture dubbed "Sequential-SAR" (S-SAR) based on multiple SAR ADCs running in parallel *(Fig. 2)*. The 40-MHz SPT7860 is the fastest of SPT's ADC family. The five devices provide sampling rates of 5, 10, 20, 25, and 40 MHz, with typical power dissipation from a 5-V rail being 75, 100, 140, 150, and 200 mW, respectively. The CS5480 is built on a 0.8-μm process; SPT's family is built on a 1-μm process.

As noted earlier, 10-bit ADCs have been cast as low-performance orphans. However, market forces and advances in technology are bringing new high-speed devices to the fore. While fine-geometry CMOS processes made 10-bit ADCs virtually as easy to build as 8-bit devices, major applications have arisen for units with sampling rates beyond a few megahertz.

For example, 5-MHz sampling rates are needed in handheld CCD document scanners; high-end scanners and low-end video applications require 10-MHz sampling rates; and standard-broadcast video camcorders need 20-MHz sampling rates. Furthermore, high-end video applications take advantage of oversampling at 25 MHz; automotive collision-avoidance radar receivers undersample at 25 MHz; and medical ultrasound scanners and professional broadcast-studio video equipment want 40-MHz sampling rates. In addition, digital communication applications undersample in the 20-to-25-MHz range.

Using an ADC in an undersampling mode requires that it provide an input bandwidth far greater than its maximum sampling rate, much like the six ICs described here *(see the table)*. The slower SPT units' input bandwidth doesn't drop off as rapidly as their sampling rate, potentially opening them up to new undersampling applications. For example, the input bandwidth of the 5-MHz SPT7835 typically runs at 100 MHz while that of the 40-MHz SPT7860 and CS5480 are 250 and 200 MHz, respectively. Thus, while all six ADCs are well equipped to undersample bandlimited signals well above their Nyquist rate, the ratio of input-signal bandwidth to sampling rate is highest among the slower ADCs.

SPECIFICATIONS FOR THE 10-BIT WIDEBAND-SAMPLING-RATE ADCs

Specification	CS5480	SPT7860	SPT7855	SPT7850	SPT7840	SPT7835
Sampling rate, MHz	40	40	25	20	10	5
Integral nonlinearity, ±bits	1	2	2	2	2	2
Differential nonlinearity, ±bits	0.5	1	1	1	1	1
No missing codes to n bits, n =	10	10	10	10	10	10
Power dissipation, mW	500/375 (t)	250/200 (t)	175/150 (t)	165/140 (t)	110/100 (t)	110/75 (t)
Input bandwidth, MHz	200	250	100	100 (t)	100 (t)	100 (t)
Pipeline delay (latency), clock cycles	18	12	12	12	12	12
Aperture jitter, ps	5 (t)	15	15	10 (t)	10 (t)	10 (t)
Acquisition time, ns	15 (t)	NA	NA	NA	NA	NA
Signal-to-(noise + distortion) (SINAD), dB						
f_t = 0.5 MHz	NA	NA	NA	NA	52	52
f_t = 1 MHz	58	55 (t)	55 (t)	52	52	52
f_t = 3.58 MHz	NA	53 (t)	53 (t)	52	52	NA
f_t = 5 MHz	NA	NA	NA	51	51	NA
f_t = 10 MHz	54	52 (t)	52 (t)	50	NA	NA
f_t = 20 MHz	50	NA	NA	NA	NA	NA
Total harmonic distortion (THD), dB						
f_t = 0.5 MHz	NA	NA	NA	NA	59	59
f_t = 1 MHz	65	60 (t)	60 (t)	57	59	59
f_t = 3.58 MHz	NA	57 (t)	57 (t)	56	56	NA
f_t = 5 MHz	NA	NA	NA	56	56	NA
f_t = 10 MHz	57	56 (t)	56 (t)	53	NA	NA
f_t = 20 MHz	53	NA	NA	NA	NA	NA
Effective number of bits (ENOB), bits						
f_t = 0.5 MHz	NA	NA	NA	NA	NA	9.2 (t)
f_t = 1 MHz	9.3	8.8 (t)	8.8 (t)	8.8 (t)	9.1 (t)	9.2 (t)
f_t = 3.58 MHz	NA	8.5 (t)	8.5 (t)	8.8 (t)	9 (t)	NA
f_t = 5 MHz	NA	NA	NA	8.7 (t)	9 (t)	NA
f_t = 10 MHz	8.7	8.3 (t)	8.3 (t)	8.5 (t)	NA	NA
f_t = 20 MHz	8	NA	NA	NA	NA	NA
Intermodulation distortion (IMD), dB						
f_t = 1 MHz and 1.05 MHz	60 (t)	NA	NA	NA	NA	NA
Differential phase, degrees	1	1 (t)	1 (t)	1 (t)	1 (t)	1 (t)
Differential gain, %	1	1 (t)	1 (t)	1 (t)	1 (t)	1 (t)
Operating temperature range, °C	–40 to +85 –55 to +125	0-70	0-70	0-70	0-70	0-70
Price (l000-unit lots), $	40.00	43.50	25.60	18.30	13.70	9.60

Note: All specifications are maximum or minimum unless labled t (typical), with the ADCs operating from a 5-V power-supply rail, and over the specified operating-temperature range.
NA = Not available

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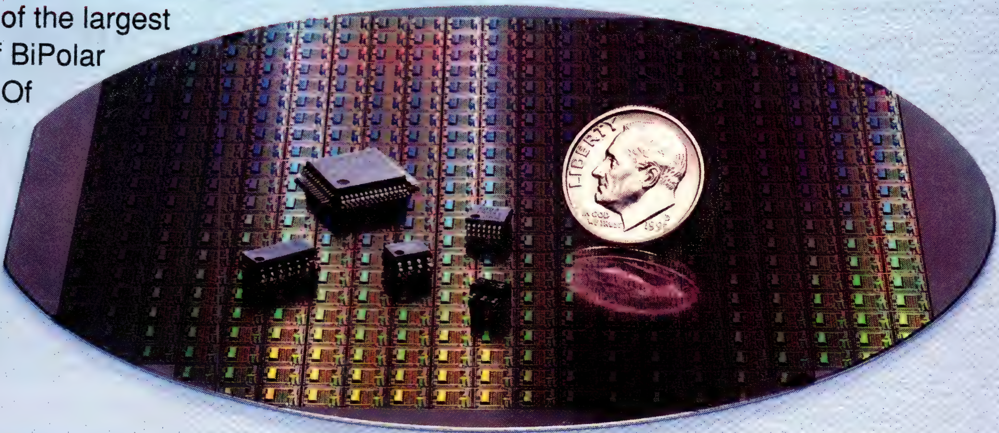

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PART NO.	DESCRIPTION	PACKAGE
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NJU3711	8-bit Serial In Parallel Out	D, M14
NJU3712	8-bit Serial In Parallel Out with Cascade Function	D, M16
NJU3713	12-bit Serial In Parallel Out	D, G18
NJU3714	12-bit Serial In Parallel Out with Cascade Function	D, G20
NJU3715	16-bit Serial In Parallel Out	L, G22
NJU3716	16-bit Serial In Parallel Out with Cascade Function	L, DMP24
NJU3718	20-bit Serial In Parallel Out with Cascade Function	L, G28
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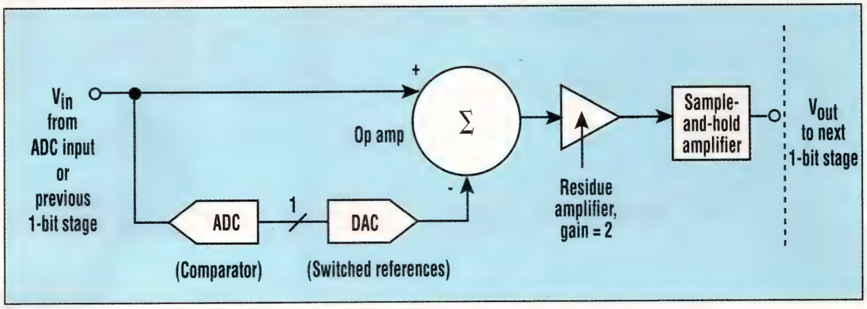
These ADCs could find their way into classic data-acquisition systems (DASs). Many such systems contain tens or even hundreds of sensors (such as thermocouples) and/or sense other signals (e.g., power-supply voltages) in which 8- or 9-bit accuracy is sufficient. All of these ADCs offer sampling and 8- or 9-bit integral linearity, which is minimum for the SPT and Crystal units, respectively. Consequently, a multichannel multiplexer and a programmable-gain-amplifier (PGA) can be added ahead of the ADC to form the DAS.

If full 10-bit accuracy is required, several multiplexer channels can be fed several voltages from references, creating a system calibration that includes the multiplexer and, if used, the PGA (in virtually all of the dynamic applications for these ADCs, dc errors like integral and differential nonlinearity, offset, and gain have minimum effect).

When monitoring a 100-channel system with the 5-MHz SPT7835, the per-channel sampling rate is still 50 kHz. This permits sampling ac signals, such as those from vibration sensors, at Nyquist rates up to 25 kHz. And because the ADC features a typical input bandwidth of 100 MHz, undersampling can be performed on significantly-higher-frequency bandlimited input signals.


V_{in} from ADC input or previous 1-bit stage
+
Σ
Op amp
-
ADC
1
DAC
(Comparator)
(Switched references)
Residue amplifier, gain = 2
Sample-and-hold amplifier
V_{out} to next 1-bit stage

3. EACH STAGE OF THE PIPELINED ADC consists of identical 1-bit stages that decide if the input signal is larger or smaller than a reference voltage. If it's larger, the stage codes that bit as a logic 1. If it's smaller, the bit is coded as a logic 0. The code is applied to the DAC and subtracted from the input. The difference is multiplied by two in the residue amplifier, grabbed by the sample-and-hold amplifier, and fed to the next stage.

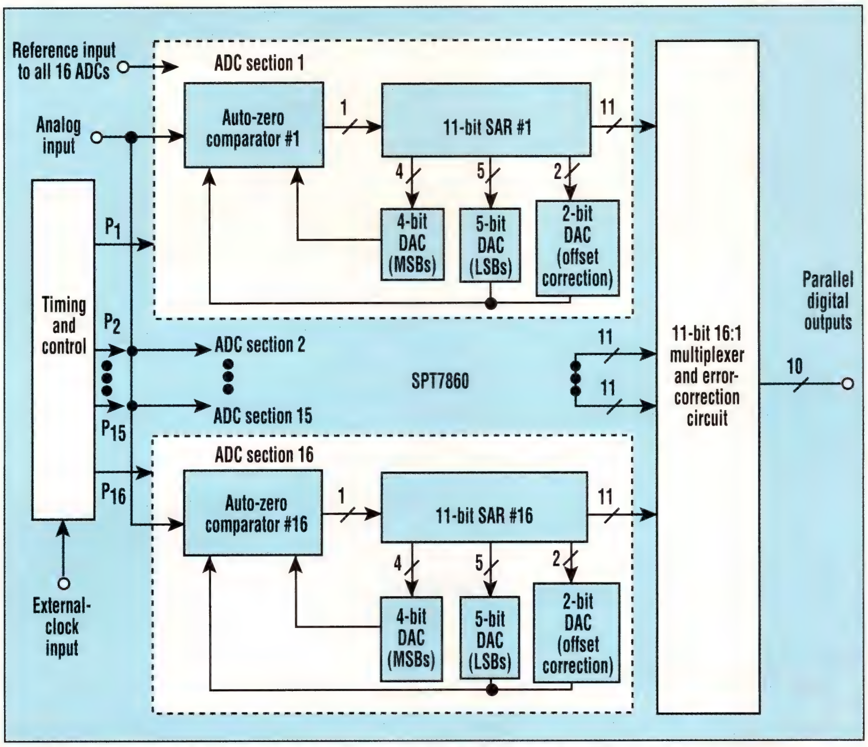
SEQUENTIAL SAR

SPT's proprietary sequential-SAR architecture represents an extension of the common SAR ADC technique *(Fig. 2, again)*. In the S-SAR architecture, an array of multiple 11-bit SAR ADCs, each with its own individual differential-input sample-and-hold amplifier, sequentially convert (sample and quantize) the analog input. The three slower SPT converters each employ 8 SAR ADCs, while the two faster units each sport 16.

By using a single reference divider for each DAC in all 16 SARs, as well as a 1-μm CMOS process, the SARs can be crammed onto a die that's just 100 by 150 mils. Eventually, the converters will shrink in a 0.8-μm process, increasing both performance at 40 MHz and overall accuracy due to improved device matching.

Each of the 16 SARs in the 40-MHz SPT7860 samples its input at 2.5 MHz. Because every SAR is driven by phase clocks P_1 through P_{16}, they take their input sample sequentially at 400-ns (1/2.5-MHz) intervals. The 16 sequential, 11-bit, parallel-digital outputs feed an 11-bit, 16-input multiplexer. The multiplexer combines the 16, 11-bit time-interleaved 2.5-MHz digital words into a train of parallel 11-bit words to provide the 40-MHz word rate (2.5 MHz multiplied by 16 = 40 MHz). After combining the output of the 16 SAR ADCs, the circuit uses the extra 11th bit for digital error correction. The correction algorithm eliminates errors due to the finite settling time of the ADC's front end, permitting a greater sampling rate. It also converts the 11-bit word to a 10-bit word. An external clock in the timing and control block develops the 16 phase clocks.

The S-SAR also features a novel autocalibration scheme that eliminates the gain and offset of each of the 16 ADCs in the array. This procedure ensures that dynamic errors aren't introduced by the converter topology. The calibration is performed at the beginning of each



2. BY RUNNING 16 SAR ADCs IN PARALLEL at 2.5 MHz, the SPT7860 ADC developed by Signal Processing Technologies can achieve a 40-MHz sampling rate (2.5 multiplied by 16 = 40). The 16 SARs sequentially sample the input every 40 ns.

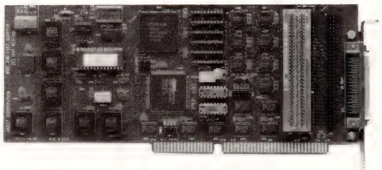
SCSI 1 & 2

Test Equipment

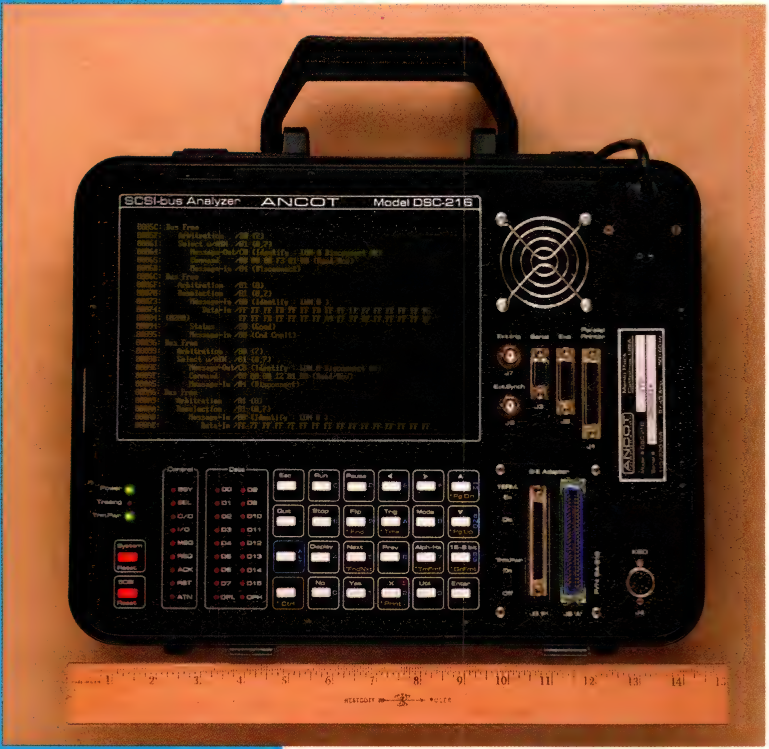
Target Emulator

Bus Monitor

Mutiplexer Switch



Initiator Emulator



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ADC's conversion. As a result, the ADC can handle changes in operating conditions such as temperature or the 5-V power rail.

At the heart of each SAR lies an autozero comparator with a fully-differential input. Autozeroing improves rejection of the high-frequency noise typically present in high-data-rate systems. In addition, a unique sampling sequence used in the front end of the comparator reduces the effect of charge injection. Prior to each SAR's sampling of the signal, three clock cycles are used to sample the common-mode voltage, the offset error, and the gain error. Using this technique, the ADC can interpret pedestal error (caused by device mismatch) as offset, which is removed by autocalibration.

An external voltage reference between 3 and 5 V sets the full-scale input signal range. Depending on the dc accuracy required by the application, a well-filtered version of the 5-V analog supply rail may be used.

As noted earlier, Crystal's CS5480 employs a 13-bit pipelined architecture in which the first four bits (the MSBs) are created by a pair of parallel pipelines running in a "ping-pong" mode *(Fig. 1, again)*. The two pipes alternately (in a 50% duty cycle) start quantizing, at 20 MHz, the voltage held by the front-end sample-and-hold amplifier.

The CS5480 operates in a either a single-ended, or differential-input configuration. It provides a maximum full-scale input-voltage range of 1.2 V p-p when it's connected for single-ended operation and double that when connected for differential operation. The pair of parallel pipes cut analog power needs by a factor of two due to the square-law relationship between the g_m and the drain current for CMOS devices. The parallelism also increases immunity to clock-duty-cycle variations because these stages run off an internally-generated and divided clock. Prior to connection to the output pins, logic combines the MSB data bits from the left- and right-hand pipeline, $d_{l(0-3)}$ and $d_{r(0-3)}$, respectively.

Fully-pipelined ADCs use one comparator per bit. Thus, 23 comparators are used for the CS5480: 8 comparators for the first four bits (the MSBs), 9 for the LSBs, and 6 more for the overrange and underrange function. The 40-MHz SPT converter uses 16 comparators. The pipelined architecture might be looked upon as the ultimate in multistep ADCs with a separate step or stage for each bit *(Fig. 3)*. Whereas a typical two-step (half-flash) architecture would require a residue amplifier with a gain of 25 or 32, as well as 64 comparators, the pipelined approach maximizes speed by minimizing gain, dropping this interstage gain to just two. The last stage needs only a comparator.

The DAC consists of a simple circuit that switches between a pair of reference voltages. It can be used for all stages. Both the DAC and the ADC (the comparator) are 1-bit circuits, therefore they're inherently linear. Unlike the SPT converters that require an external reference, the CS5480 features an internal 1.2-V reference that can be overridden by an external reference.

The CS5480 employs an unusual digital-calibration scheme that takes advantage of the three overlap bits provided by the 13-bit converter and the output bits of each stage. It eliminates the effects of capacitor mismatch, offsets, and finite gain error. The calibration scheme ensures that the ADC function is as close to its normal operation as possible during calibration. This technique is based on the concept that any curved line looks straight if viewed over a small enough interval. That is, a curved line represents a collection of straight lines connected end to end.

The ADC's unaltered transfer function can be considered a curved line broken into equal-sized straight lines, or chords. These chords can be pieced together, or mapped onto an actual straight line representing the true dc transfer function. The inherent accuracy from the digital semiconductor process used determines the size of the interval over which the ADC's transfer function is straight. A more accurate analog process provides a longer straight-line interval than a less-accurate digital process. The first four stages of the pipeline represent a chord *(Fig. 1, again)*.

During calibration, the ALU in the calibration controller digitally maps the actual transfer function onto the ideal transfer function. The ALU calculates the gain and offset for the four MSBs of each chord. These correction values (numbers) are stored in RAM and applied to the digital multiplier. As a signal passes down the pipeline, the digital multiplier performs a shift-and-add-multiply operation on the digital bits serially, and in real time.

The accuracy of the technique determines the number of chords. The lower-order bits determine the straight-line interval while the higher-order bits (MSBs) are being calibrated. The MSBs, $d_{l(0-3)}$ and $d_{r(0-3)}$, become the address to the RAM. With the higher-order bits calibrated, any channel-to-channel mismatch between the parallel paths (which might otherwise show up as "tones") are calibrated out. Note that the overrange bits are used internally—they're not brought out to pins.

The parallel architecture and its calibration circuits are only practical because each ADC's 174-by-205-mil die is built on a fine-line (0.8-µm) CMOS process. About half the die is taken up by the digital calibration circuitry, with the calibration controller and digital multiplier using up about 75% of this area.

Both Crystal and SPT provide evaluation boards for their converters. The boards also contain reconstruction DACs.☐

PRICE AND AVAILABILITY

Crystal's CS5480 10-bit/40-MHz ADC comes in a 28-pin PLCC as well as 28-pin LCCs. It's rated for operation from –40 to +85°C. Military-temperature-range converters will be available in the future. See the table for pricing in quantities of 1000. Converters will be available in small quantities within 90 days.

Crystal Semiconductor Corp., P.O. Box 17847, Austin, TX78760; Mike Paquette, (512) 445-7222, fax: (512) 462-2723.

CIRCLE 515

SPT's family of 10-bit, 5-to-40-MHz ADCs come in 28-pin DIPs, CERDIPs, and SOICs. The ICs are rated for operation from 0 to 70°C. See the table for pricing. Small quantities are available from stock.

Signal Processing Technologies, Inc., 4755 Forge Rd., Colorado Springs, CO 80907; Rick Mintle, (719) 528-2314, fax: (719) 528-2370. **CIRCLE 516**

HOW VALUABLE?	**CIRCLE**
HIGHLY	527
MODERATELY	528
SLIGHTLY	529

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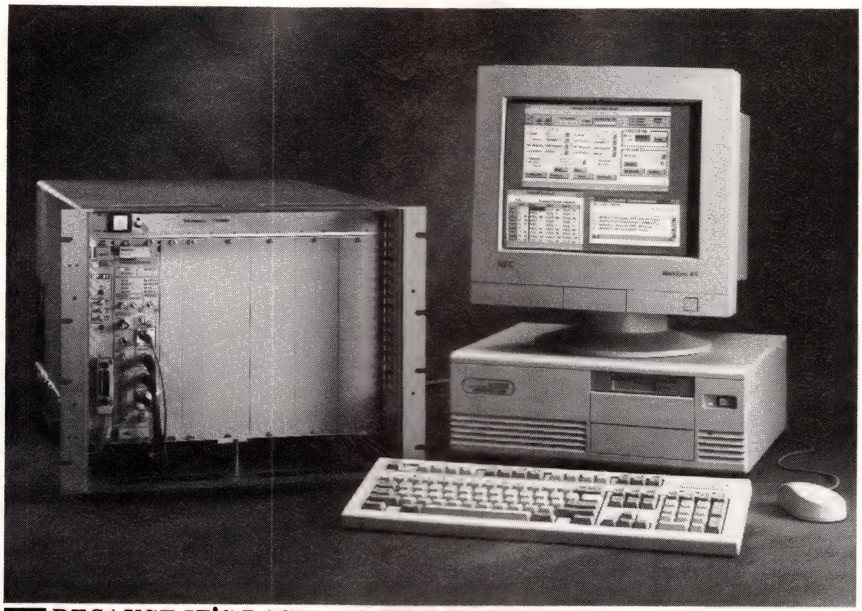

BECAUSE IT'S BASED ON THE VXI instrument-on-a-card standard, the SX4610 SDH/Sonet analyzer offers a smaller footprint than previous test solutions. Moreover, it ensures greater flexibility when choosing additional hardware and software.

VXI SYSTEM PERFORMS FULL SDH/SONET TESTING

USING AN OPEN ARCHITECTURE ENSURES THAT THE ANALYZER CAN GROW AND MATURE IN TANDEM WITH COMMUNICATION STANDARDS.

JOHN NOVELLINO

This is the year when it's all expected to come together for the data-communications industry. With the mounting popularity of broadband digital applications, a number of products featuring technologies like asynchronous transfer mode (ATM) are scheduled to be introduced this year (ELECTRONIC DESIGN, *Nov. 11, 1993, p. 18)*. The strong demand for such products is forcing network-element suppliers to reevaluate their manufacturing test strategies. Thus, test-system size, throughput, and flexibility are more important than ever.

Regardless of the specific application—ATM, video, interactive multimedia, etc.—this burst of communications growth will center on the two major data-transmission standards: the worldwide Synchronous Digital Hierarchy (SDH) standard, and the U.S. Synchronous Optical Network (Sonet) standard. The fact that the standards allow equipment from different vendors to be used in a system will ensure SDH/Sonet's widespread use.

To meet the increasing test needs of telecommunications OEMs, Tektronix introduced the SX4610 SDH/Sonet analyzer. The VXI-based system offers complete SDH/Sonet payload and overhead test capabilities. Lying at the heart of the system is the VX4610 generator-receiver module. Also included are a slot-0 module, a 13-slot C-size mainframe, a personal computer with an IEEE-488 (GPIB) interface and cable, and graphical-user-interface software. A SCPI-like (Standard Commands for Programmable Instruments) command structure and an open-system architecture facilitate VXI system integration and test-program development.

A BETTER ALTERNATIVE

Tektronix notes that up to now, the two main approaches to automating SDH/Sonet manufacturing test have been ATE systems and the integration of "rack-and-stack" IEEE-488 instruments. Disadvantages of these approaches include size, instrument integration, and software development and maintenance considerations that increase operating cost. The VXI-based SX4610 SDH/Sonet analyzer falls in between ATE at the high end and an IEEE-488 system in price and performance.

VXI offers a number of distinct advantages. The standard's form factor cuts space requirements. Its modularity reduces system downtime and allows sharing of system resources. In addition, VXI offers a higher level of integration, a faster bus, shorter interconnects, and simplified test fixturing. The result is improved performance and test throughput. Of course, using the VXI standard also allows test engineers to add modules from other vendors to the system.

The two-slot message-based VX4610 module delivers comprehensive SDH/Sonet production testing. It supplies STS-1/3 and STM-1(E) signal interfacing with expansion options for optical signals. An add-on module provides DS1/DS3 and E1 add/drop capabilities. This option can be added to the VX4610 itself; therefore separate VXI modules aren't needed. Tests available include bit-error rate, alarm simulation/response, APS simulation/response, failure-state tracking, byte-change tracing, and pass/fail.

With the module, users can generate and capture up to 54 STM-1/STS-3C frames. Triggering capabilities include programmable position, an output to other instruments, and an input from an external source. Users can define unique bytes in background channels to allow easy identification of payloads in demultiplexing. An internal memory is included to store test sequences. The module performs section and path overhead monitoring and offers full byte-level access and manipulation.

This high level of integration affords the analyzer system several advantages. The reduced module count lowers cost, cuts intermodule operation conflicts, and simplifies test program development and maintenance. Additionally, reduced intermodule communications creates a higher potential throughput.

The analyzer's user interface is optimized to simplify and speed up test-program development. VXI's open-system architecture allows a wide choice of program-development platforms and environments. Users can select Basic, C, or any other compatible program-development language.

The message-based command structure of the VX4610, which uses word-serial communications, simplifies the module's integration into existing VXI systems, including those incorporating other vendors' equipment. Control and I/O functions are accessible through an understandable, high-level, SCPI-like command structure that follows industry-wide conventions. For example, the Get and Set command structures are GPIB-compatible and can be edited as ASCII strings.

Two features of the graphical interface—Command Buffer and Command Builder—further simplify test-program development. Command Builder allows users to buffer command strings as macros. The macros can later be copied and pasted directly into future test programs as needed, greatly reducing the amount of keyboard entry required. Similarly, Command Monitor saves time in test-program optimization and maintenance by supplying the user with a visual representation of command traffic.

Realizing that the SDH/Sonet standards are relatively new and still evolving, Tektronix made sure that the VX4610 could be upgraded with minimum disruption by users in the field. The module's field-programmable gate arrays hold the entire firmware for measurement functions. Any changes to the SDH/Sonet test requirements can be distributed on a DOS-compatible disk that users are able to download to the module from a PC.

The user need not remove the VX4610 from the mainframe to return it to the manufacturer for an upgrade of firmware, because the download can be done over the bus from the system controller. As a VXI-based system, the SX4610 will serve as a convenient platform for expansion as the user's needs grow or change.

COMPATIBILITY IS KEY

The open-measurement environment designed into the SX4610 allows users to integrate into the system the best software and hardware available from any vendor. In particular, the analyzer's software and test programs are compatible with Tektronix's new SDH and Sonet portable test sets for installation and maintenance.

The portable sets—the CTS 750 for SDH and the CTS 710 for Sonet—supply most of the measurement capabilities of the VX4610 module. Test routines developed by the manufacturing side for the VX4610 can be stored on a disk for use with portable units in the field. By doing so, manufacturers can ensure that SDH/Sonet installation and acceptance tests are being performed according to specifications.☐

PRICE AND AVAILABILITY

The complete SX4610 SDH/Sonet analyzer system costs $55,000. Purchased separately, a VX4610 SDH/Sonet generator-receiver module with a 52- and 155-Mbit/s electrical interface costs $40,000. Delivery is 12 to 14 weeks after receipt of an order. Options available include 52-, 155-, and 622-Mbit/s optical interfaces, and DS-1/DS-3 and E1 tributary testing.

Tektronix Inc., Test and Measurement Group, P.O. Box 1520, Pittsfield, MA 01202; (800) 426-2200. **CIRCLE 511**

HOW VALUABLE?	**CIRCLE**
HIGHLY	530
MODERATELY	531
SLIGHTLY	532

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PRODUCTS NEWSLETTER

Fast SRAMs Access In 30 ns, Run From 3.3 V

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Reduced Prices Boost FLEX 8000 Attraction

With a cost reduction of up to 30% for members of its FLEX 8000 family of programmable logic devices, Altera Corp., San Jose, Calif., expects to improve the family's cost/performance ratio and boost the designer's interest in using the chips for circuit prototyping and production. The reduced prices now position some FLEX 8000 circuits at levels between two and three times that of a gate array—a level at which the company expects some gate-array users to cross over to the field-programmable devices. For instance, the 2500-gate EPF8282 now sells for $11 in large quantities ($23.95 each in 100-unit lots). Considering the instant turnaround, the non-existent non-recurring engineering charges, and reduced inventory risks, this makes it competitive with gate arrays. The price for the 4000-gate EPF8452QC160-3 was cut by more than 20%, and it now costs $59.50 each in lots of 100 units. The 8000-gate EPF8820RC160-3 also dropped to $165 each in similar quantities. Higher-speed versions of the FLEX chips were also price reduced. *DB* **CIRCLE 941**

CASE Tools Has Multiuser Version

This month, look for a workgroup or multiuser edition of the EasyCASE software engineering tools for Windows 3.1. With the workgroup edition, multiple EasyCASE users will be able to concurrently access a project located in a common area on a server. From Evergreen CASE tools Inc., of Redmond, Wash., the upgrade has chart- and data-dictionary locking at the record and file levels, access control with security, a read-only mode, a user list, and project export and merge capabilities. The workgroup edition works with DOS, Windows, or Novell networks that are NetBIOS-compatible. Pricing is available on request: (206) 881-5149. *SVT* **CIRCLE 942**

Verilog Model Compiler Creates Object Files

The Verilog Model Compiler (VMC) from Chronologic Simulation, Los Altos, Calif., turns models into object files that can be linked with Open Verilog International (OVI) compliant simulators. Because end users don't need the source code, silicon vendors and other model suppliers can distribute their Verilog models to designers and still retain security of their proprietary code. That's because VMC changes the way that designers interact with silicon vendors. Using VMC, silicon vendors or other model owners create object versions of Verilog models, which are then licensed or sold to logic designers for simulation. These object files can be linked with other object files that comply with the OVI Verilog Programming Language Interface. In addition, Chronologic claims that VMC-compiled models can run up to ten times faster and use up to ten times less memory than models distributed in encrypted source form. The VMC software runs on Unix workstations and costs $60,000 plus royalties for models shipped. Call (415) 965-3312. *LM* **CIRCLE 943**

CAD System Does RF And Microwave Design

CADnexion, a PC-based electrical CAD (ECAD) system from Bay Technology, Aptos, Calif., is tailored for such high-frequency designs as microwave, rf, and analog systems. Users can easily move from mechanical CAD systems such as AutoCAD into the Cadnexion system. With CADnexion, an electrical net list can be imported or exported by a facility that also provides easy transport of Gerber, DXF, GDS-II, and NC-Drill files. The main difference between CADnexion and other ECAD systems is its wide range of design support, and its use of the mechanical CAD methods of geometry creation and editing. For example, users can create unusual geometries for that special microwave strip line or rf circuit using the arcs, circles, polygons, paths, and donuts that the tool supports. The cell-based database structure allows for easy cut-and-paste operation. CADnexion supports keyboard and/or menu-driven entry of creation and editing commands. CADnexion is available now, starting at $4995. Call (408) 688-8919. *LM* **CIRCLE 944**

Edited by Clifford Meth

NCR

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CIRCLE 246 FOR U.S. RESPONSE
CIRCLE 247 FOR RESPONSE OUTSIDE THE U.S.

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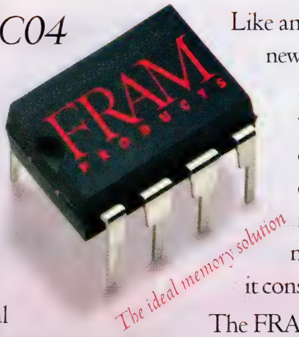
With 10 millisecond write-time delays, serial EEPROMs are bound to fail...even in moderate tests of speed.

But there's hope. Because Ramtron's new 24C04 serial FRAM product has no write delay.



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RAMTRON

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CIRCLE 248 FOR U.S. RESPONSE **CIRCLE 249 FOR RESPONSE OUTSIDE THE U.S.**

BUILD FULL-FUNCTION, LOW-POWER PC/AT BOARD IN JUST 7 IN.^{2}

Designed for use with portable PCs, the Fir system controller from PicoPower Technology is a two-chip set that helps build a full-function PC/AT system in just 7 in.^{2}. The platform has room for 4 Mbytes of RAM, local-bus graphics, two PCMCIA slots, and other I/O functions.

The I/O functionality comes from a pair of 3-V ICs developed by National Semiconductor Corp., the PC87912VJG keyboard microcontroller, and the PC87334VJG Super I/O device. The parts both include extensive power-management features to permit more than eight hours of battery life in a typical PC configuration.

The 8-bit PC87912VJG supplies keyboard control and scan, internal RAM, and real-time clock functions. It requires no additional external devices (such as PROMs, keyboard, or logic buffers) and it can run at speeds up to 24 MHz. In its lowest power mode, the IC consumes less than 10 µA by shutting off its crystal oscillator. The Super I/O part has a built-in serial IR communications interface that allows wireless data transfer at speeds up to 115 kbaud. The PC87912VJG sells for $19 and the PC87334VJG costs $20, both in quantities of 100.

The two Fir components, the PT86C868 and the PT86C818, are built with an open architecture, letting third-party designers chose any standard CPU, graphics and system controllers, and I/O and peripheral subsystems. In addition, they support a built-in IDE local bus, the VL-Bus, and 3- or 5-V microprocessors running at speeds up to 50 MHz. BIOS support is available.

The PT86C868 and the PT86C818 each fit in a 144-pin thin quad flat pack. In large quantities, the set sells for $30. Samples are available now and production starts in the second quarter.

PicoPower Technology Inc., *1971 Concourse Dr., San Jose, CA 95131; (408) 954-8880.* **CIRCLE 854**

National Semiconductor Corp., *2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052; (408) 721-5000.* **CIRCLE 855**

■ *RICHARD NASS*

DESKTOP I/O CONTROLLER INCORPORATES PORTABLE TECHNOLOGY

Designers of desktop computers are always on the lookout for ways to differentiate their systems. One of the latest crazes is to offer low-power modes, which reduces a users electric bill, and also makes the system "environmentally correct." To reduce the power draw in desktops, the designers are turning to their portable-designer brethren for advice. As a result, many of the techniques (and components) that had been specific to notebook computers are finding their way onto desktop motherboards.

One such device that employs portable technology is the SuperI/O III PC87332VLJ, an I/O device designed by National Semiconductor, Santa Clara, Calif., with a lot of input from PicoPower Technology, of San Jose, one of the leaders in low-power system design. The 3.3-V IC is pin-compatible with earlier members of the SuperI/O family, making it a drop-in replacement.

The SuperI/O III PC87332VLJ chip contains an integrated floppy disk controller, dual UARTs, and an IEEE 1284 standard parallel port. Housed in a small footprint 100-pin plastic quad flat pack (PQFP), the low-power device sells for $19 in 100-unit lots. Production quantities are available now.

National Semiconductor Corp., *2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052; (408) 721-5000.* **CIRCLE 856**

■ *RICHARD NASS*

64-BIT PROCESSORS SPEED MULTIMEDIA

Providing a 64-bit pixel port to the video memory, the Vision family of processors from S3 more than doubles the performance of the company's previous generation graphics accelerators. The family starts with two multimedia-enabled graphics accelerators—one optimized for DRAM-based systems (the Vision864) and the other optimized for higher-performance VRAM-based solutions (the Vision964). Both come with VL- and PCI-bus interfaces. The chips support a frame-buffer memory bandwidth up to 240 Mbytes/s with DRAMs, and up to 720 Mbytes/s with VRAMs.

The Vision864 drives displays ranging from 800-by-600-pixels with 16.7 million colors up to 1280-by-1024-pixel displays with 256 colors, with a 72-Hz non-interlaced refresh rate. The VRAM-based Vision964 ups the ante to 1280-by-1024-pixels with 16.7 million colors at 60 Hz, or 1600-by-1200-pixels with 65,000 colors at 72 Hz. Up to 4 Mbytes of DRAM and a 16-bit palette-DAC interface are supported by the Vison864, while the Vision964 addresses up to 8 Mbytes of VRAM and ties into a 32- or 64-bit palette-DAC interface.

A third chip is a video accelerator, the Vision/VA, which was jointly developed with IBM Corp. It complements the Vision964 and shares the graphic memory to deliver high-quality video with adjustable window sizes. Rounding out the family is the SDAC, which combines the clock generator and palette DAC on one chip. Drivers are available for Windows, Windows NT, and OS/2.

In 1000-unit lots, prices for the 208-lead PQFP-housed Vision864, Vision964, and Vision/VA are $45, $75, and $75, respectively. The 68-lead SDAC comes in 110- or 135-MHz versions and sells for $8.81 or $10.56, respectively, in similar quantities.

S3 Inc., *2770 San Tomas Expressway, Santa Clara, CA 95051-0968; Ron Yara, (408) 980-5400.* **CIRCLE 857**

■ *DAVE BURSKY*

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Tutorial 1: Asynchronous Transfer Mode
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Wednesday, Thursday, April 6, 7:

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The conference is divided into three parallel session tracks that will present technical papers and panels highlighting design approaches and issues in various themes:

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- * *Network management and diagnostic approaches.*
- * *Design approaches for high-performance internetworking products (bridges, routers, etc.).*
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FAST 4-MBIT VIDEO RAMS MOVE 16-BIT WORDS IN JUST 15 NS

Although they're not the first 4-Mbit video RAMs to hit the market, the IBM 025160, 161, 170, and 171 provide the shortest serial data access times and an extended refresh rate of 32 ms. Organized as 256 kwords by 16 bits, the VRAM includes a 256-word-deep (256 bytes) serial-access-mode video port that transfers data at just 15 ns/word—the shortest VRAM transfer time. The standard DRAM port has random-access times of 60 or 70 ns and a fast-page access mode that transfers data at 30 or 35 ns per word. The extended refresh rate eliminates extra refresh cycles typically required by other VRAMs when doing a full-screen refresh—most other VRAMs have an 8-ms refresh period.

The on-chip SAM is actually split into two 128-word by 16-bit SAMs so users can continuously transfer data by alternately loading each SAM half in the background before transferring the data. The number of bytes transferred to or from the SAM can be programmed by loading in some control bits, permitting the display controller to adjust the video line length.

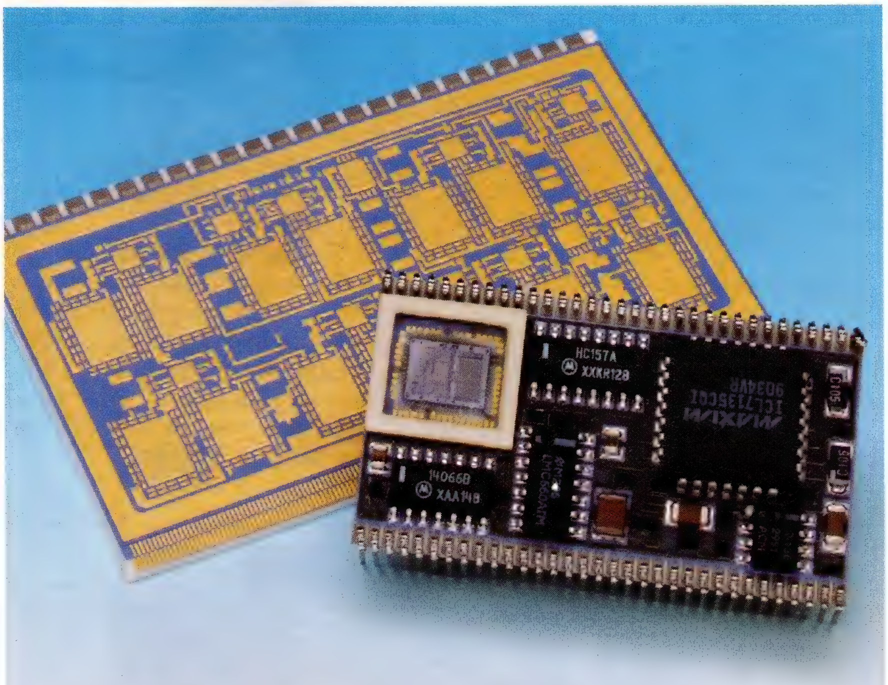
The SAM, though, is actually only half the capacity normally expected for a 4-Mbit-density VRAM. The smaller SAM saves chip area and power: This translates into lower memory and system prices. In addition, the smaller SAM, coupled with a choice of 3.3- or 5-V power-supply options, makes it possible for designers to optimize systems for low power yet achieve high performance.

The 025160 and 161 come with two Chip Enable control pins, while the 170 and 171 have two write-enable lines. Furthermore, the 160 and 170 have the standard fast-page-mode data transfer mode, while the 161 and 171 pack the newer extended-data-output mode. Also included on the chips are an 8-bit block-write capability and the ability to perform flash writes to quickly change imagery, such as background colors. A two-byte color register allows users to set background and foreground colors and many other characteristics.

The VRAMs come in wither 64-lead small-outline gull-wing or 70-lead TSOPs. Samples of the VRAMs are immediately available. In lots of 1000 units, the 5-V version sells for $35 each and the 3.3-V version is $38 each.

IBM Microelectronics Inc., *P.O. Box 7932, Mt. Prospect, IL 60056; (708) 296-9332.* **CIRCLE 858**

■ *DAVE BURSKY*



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CIRCLE 110 FOR U.S. RESPONSE
CIRCLE 111 FOR RESPONSE OUTSIDE THE U.S.

7200 RPM INCREASES HIGH-CAPACITY DISK-DRIVE SPECIFICATIONS

Two 3.5-in. form factor hard-disk drives, the VP3215 and the SP3430, boast formatted capacities of 2.15 and 4.3 Gbytes, respectively. The VP3215 is a low-profile unit that spins the disk at 7200 rpm to supply an average seek time of under 9 ms and an average access time of 13.2 ms. Using a wide SCSI-2 interface, transfer rates of 20 Mbytes/s can be achieved, aided by automated tag queuing. A 1-Mbyte multi-segmented cache memory maximizes cache hits for multiple sequential read streams while minimizing the impact on cached data.

The SP3430 uses 10 platters and 20 heads to achieve the high capacity. The drive features banded recording that yields a transfer rate better than 8.5 Mbytes/s. The cache-management algorithm built into the 2-Mbyte cache buffer results in a faster data access and higher system throughput. A 198-bit Reed-Solomon error-correction code can correct up to 80 bits/sector.

The SP3430 sells for $2595, while the VP3215 costs $1695. A drive similar to the VP3215, the VP3107 holds 1.075 Gbytes and is priced at $1145.

***Digital Equipment Corp.**, Maynard, MA 01754. Call local DEC sales office for more information.* **CIRCLE 859**

■ *RICHARD NASS*

STORE 9 GBYTES ON 5.25-IN. DRIVE

Storing upwards of 9 Gbytes had typically been an application handled by arrays of disks. Now, thanks to some advanced features, that capacity can be reached using one Elite 9 5.25-in. hard-disk drive. Such a high capacity, combined with an MTBF of 500,000 hours, opens the door to some innovative applications, including near on-line storage, digital video, and high-speed backup.

The Elite 9 boasts an average seek time of 11 ms and an average latency of 5.56 ms, both due to its 5400-rpm spin rate and an all-aluminum actuator assembly. Internal data rates average 7 Mbytes/s. Both fast and fast/wide SCSI-2 models are available for either a 10- or 20-Mbyte/s external transfer rate. In addition, drives with either single-ended or differential drivers and receivers are offered.

Available in the first quarter of next year, the Elite 9 (model ST410800N) sells for $3450. Product volumes should be available in the second quarter.

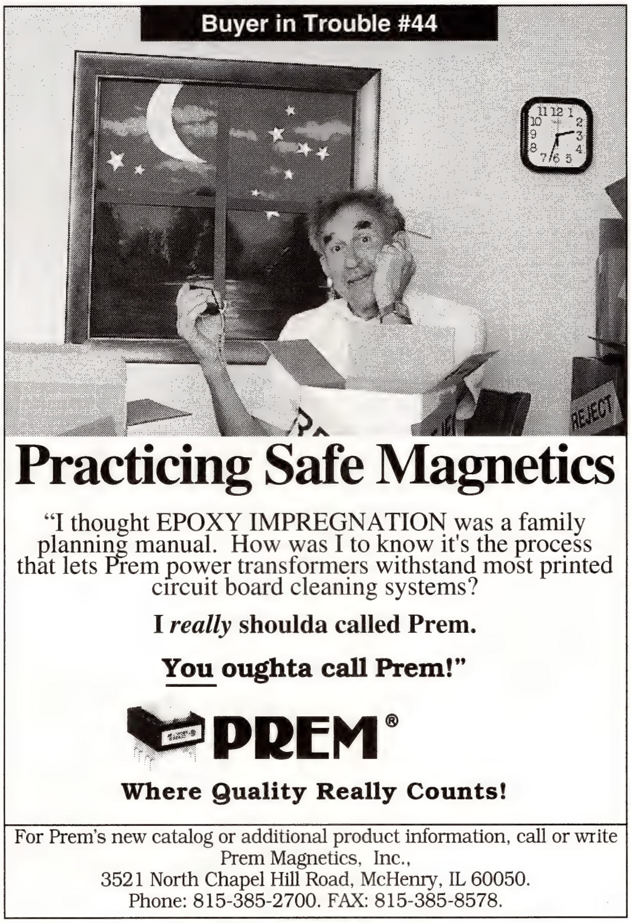
***Seagate Technology Inc.**, 920 Disc Dr., Scotts Valley, CA 95066; (408) 438-6550.* **CIRCLE 860**

■ *RICHARD NASS*

CD-ROM WRITER SPINS SIX TIMES FASTER

The PCD Writer 600 disk writer records data onto CD ROMs at a rate that's six times faster than conventional drives. This supplies a transfer rate of 900 kbytes/s. When combined with the Writable CD Production Station, automated disk recording can occur on a maximum of 75 disks. This is done using the Disc Transporter, which automatically inserts and removes the media from the PCD Writer 600. The system comes bundled with CD publishing software to supply system control and batch programmability for recording. The complete station, which fits on a tabletop, will be available early this year. RN

Eastman Kodak Co., 343 State St., Rochester, NY 14650. **CIRCLE 861**



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CIRCLE 138 FOR U.S. RESPONSE
CIRCLE 139 FOR RESPONSE OUTSIDE THE U.S.

MAGNETO-OPTICAL DRIVE WEIGHS JUST 17 OZ.

The result of a development agreement between IBM's Storage Systems Div. and Philips' Consumer Electronics Key Modules Group resulted in the model MTA-3127 3.5-in. magneto-optical disk drive. The drive is designed for such applications as multimedia and desktop publishing for portable computers as well as desktop systems.

The 1-in.-high, 17-oz. rewritable drive boasts a capacity of 127 Mbytes on removable media. Because the drive boasts an average power dissipation of just 4.3 W, no special cooling methods are required. Another feature of the drive is an automated write-calibration technique that optimizes the power used for read and write operations. Advanced sealing techniques help avoid contamination of the drive's optical components. Available now, the MTA-3127 magneto-optical drive costs $595 in single quantities. RN

IBM Corp., 1133 Westchester Ave., White Plains, NY 10604. **CIRCLE 862**

REMOVABLE DISK HOLDS 260 MBYTES

Consisting of an intelligent IDE controller card, a pocket-sized disk cartridge, and a bracket for 5.25- and 3.5-in. disk drive bays, the Intelligent family of removable disk drives hold up to 260 Mbytes per cartridge. The system allows users to remove or insert cartridges without turning off the computer. The disks can even be hot-swapped during an application. The controller card, which can be configured as a secondary controller, adjusts to any size cartridge. The installation kit, which consists of the controller, brackets, cables, and all software, sells for $150. An 80-Mbyte cartridge is priced at $399, while a 180-Mbyte unit costs $599. RN

Logisys Inc., 1275 S. Lewis St., Anaheim, CA 92805; (714) 533-6688. **CIRCLE 863**

SYSTEM COMMUNICATES OVER IR LINK

Wireless communications is one of the applications that the PadPlus RF is suited for. The pen-based mobile computer performs transparent wireless client-server and peer-to-peer LAN communications. The communicator device built into the system boasts a maximum range of 300 ft. Data is transferred at a burst rate of 242 kbits/s over three full channels. Designed around a 16-MHz V30 microprocessor (8086-compatible), the system measures 10 by 4.6 by 1.5 in. and weighs under 2 lbs. The rechargeable battery lasts up to four hours. All I/O is handled through a Type 2 PCMCIA expansion slot, a serial infra-red link, a standard serial port, or a keyboard. The PadPlus RF is priced at $2449. RN

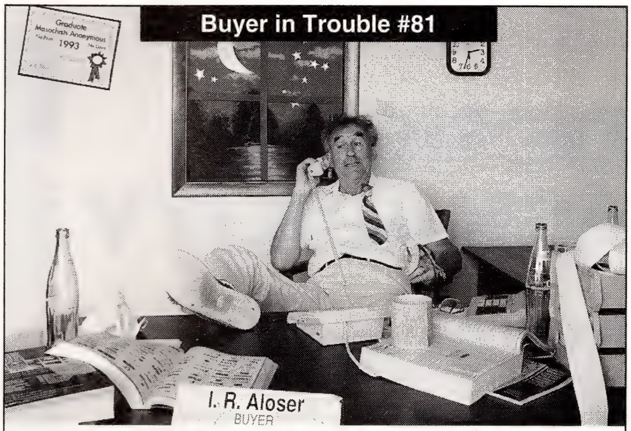
Fujitsu Personal Systems Inc., 5200 Patrick Henry Dr., Santa Clara, CA 95054; (408) 982-9500. **CIRCLE 864**

MAGNETO-OPTICAL DRIVE STORES 2 GBYTES

With storage capacities ranging up to 2 Gbytes per 5.25-in. disk, the OD152 rewritable magneto-optical disk-drive family achieves its high capacity by combining two advanced storage techniques—zoned constant angular velocity (ZCAV) and mark-edge recording. I/O transfers are handled through a SCSI interface. The drive offers an average data-access time of 50 ms and a transfer rate of 10 Mbytes/s.

Two versions of the drive are available. The OD152S/D-1 is a half-height unit that fits into an available drive bay within the system. The OU152S/D-1 is an external model that comes in a sealed unit, complete with a power supply. The MTBF of either unit is 80,000 hours. The internal drive sells for $3300 and the external unit costs $3850, both in single quantities. In addition, a full-height library drive, the OL-F152S/D-2, is available. It offers similar features and starts at $24,000. Media is now available from Maxell (for $250), and in the near future from Verbatim and 3M. RN

Hitachi America Ltd., 200 Sierra Point Pkwy., Brisbane, CA 94005; (415) 589-8300. **CIRCLE 865**



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CIRCLE 140 FOR U.S. RESPONSE
CIRCLE 141 FOR RESPONSE OUTSIDE THE U.S.

HARD-DISK DRIVE FAMILIES ROUND OUT HIGH- AND LOW-ENDS

Two families of hard-disk drives fill out the low- and high-ends of Quantum's line. At the low end, the Daytona family squeezes 256 Mbytes of data into a 12.5-mm-high package. Other members of that 2.5-in. form-factor family include a 514-Mbyte 19-mm-high model and 127- and 341-Mbyte units. All the drives in the family are designed to withstand a non-operating shock of 300 Gs, making them suitable for portable systems. The drives also boast a disk-to-buffer transfer rate of 36 Mbits/s and an average seek time of 17 ms, due to the 4500-rpm spin rate. Samples of the Daytona family are available now, with production starting in January. Prices range from $250 to $695.

At the high-end of the disk-drive line are the Empire 1440 and 2160 drives. This family is built with a PRML (partial response/maximum likelihood) read-channel technique. The PRML technology allows more bits to be packed onto the disk without sacrificing data integrity, while still employing the existing media and thin-film heads. The PRML architecture employs digital data detection and an advanced recording code to achieve very fast internal data rates while running at typical analog read-channel speeds. The Empire drives each fit a 3.5-in. form factor. The 2160 stores 2.16 Gbytes, while the 1440 holds 1.44 Gbytes. They come with SCSI-3 fast and wide interfaces. The 1440 sells for $1195 and the 2160 costs $1495.

***Quantum Corp.**, 500 McCarthy Blvd., Milpitas, CA 95035; (408) 894-4000.* **CIRCLE 866**

■ *RICHARD NASS*

SPARC WORKSTATION FITS SLIM-LINE PACKAGE

Based on a 50-MHz microSparc RISC microprocessor, the PowerLite workstation fits in a slim-line package. The platform can be configured with up to 80 Mbytes of main memory and over 1 Gbyte of internal disk space. It comes preloaded with Solaris 1.1C to insure complete compatibility with Sun workstations. Two display options are available—either 640 by 480 or 1024 by 768 pixels. Each is based on a 10.4-in. diagonal active-matrix LCD. An optional expansion unit can add extra hard disks, SBus slots, and SCSI peripherals. The PowerLite comes bundled with a series of software applications, including network administration and connectivity and fax management. Prices for the PowerLite, with a 340-Mbyte hard drive, start at $9995. RN

RDI Computer Corp., 6696 Mesa Ridge Rd., Bldg. A, San Diego, CA 92121; (619) 558-6985. **CIRCLE 867**

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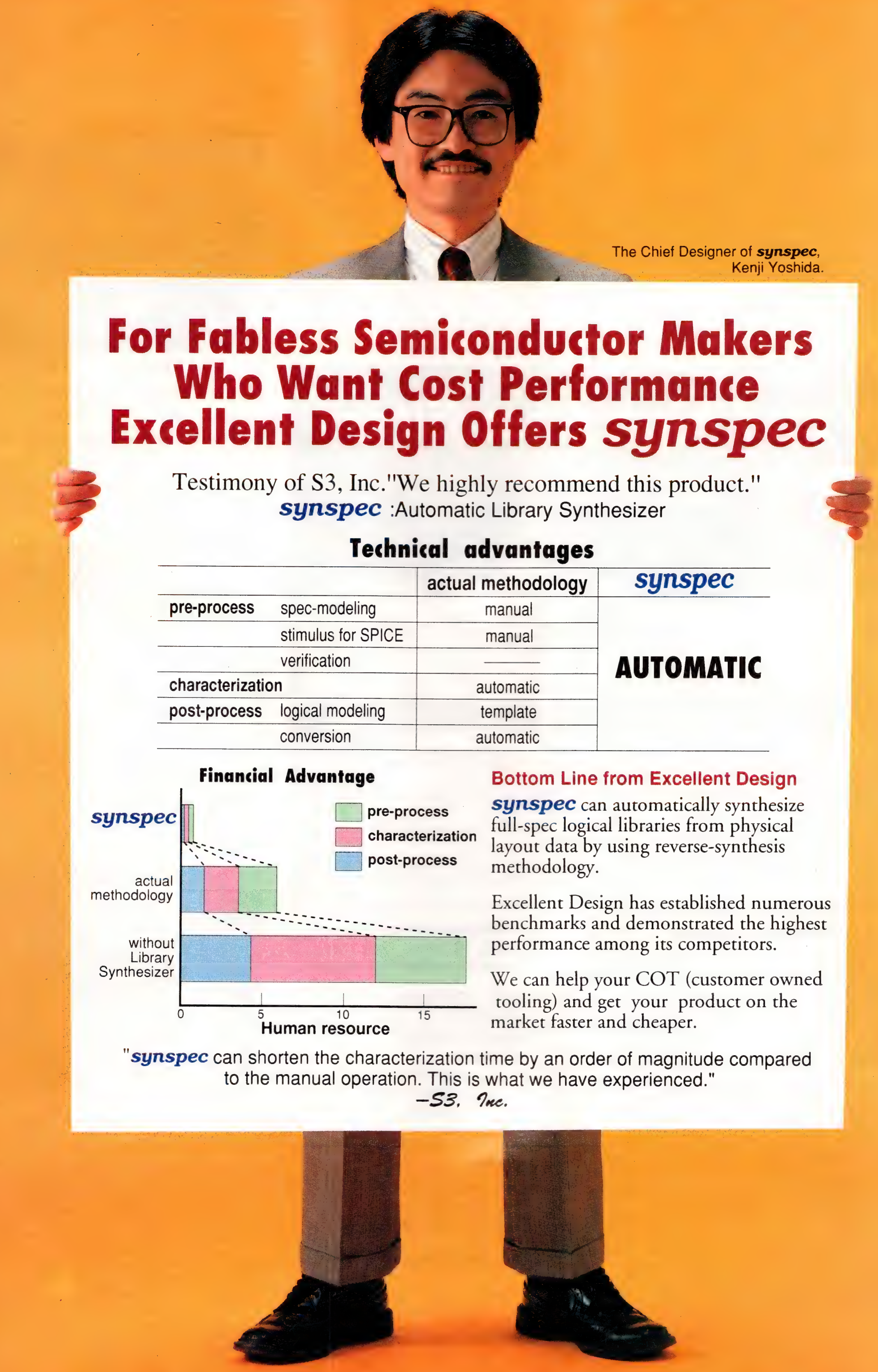
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CIRCLE 102 FOR U.S. RESPONSE **CIRCLE 103 FOR RESPONSE OUTSIDE THE U.S.**

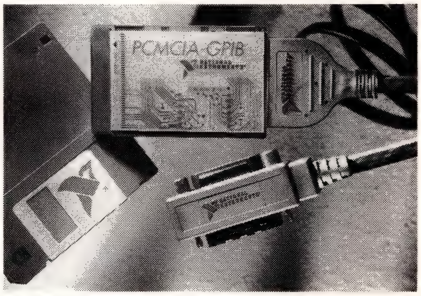
COUNTER-TIMER MAKES MULTIPLE MEASUREMENTS

A half-rack size, IEEE-488-compatible counter-timer offers a total of 13 measurement functions. The Model 776 has two input channels for measuring frequencies to 225 MHz. The Model 776/2.4G version adds a channel C that operates from 50 MHz to 2.4 GHz. The 776's 10-MHz crystal oscillator supplies 5-ppm stability. The 776/2.4G uses a temperature-compensated crystal oscillator that delivers a 0.1-ppm/month time base. Besides frequency, measurements include one-shot or average period, pulse width, and A-to-B time interval; phase; event counting; channel A/B or C/B ratio; and voltage peak on channel A. The instrument can output 100 ASCII-formatted readings per second to the IEEE-488 bus. The Model 776 costs $1995, with delivery in two weeks. The Model 776/2.4G, which will be available in the spring, costs $2595. JN

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, OH 44139; (800) 552-1115 or (216) 248-0400. **CIRCLE 868**

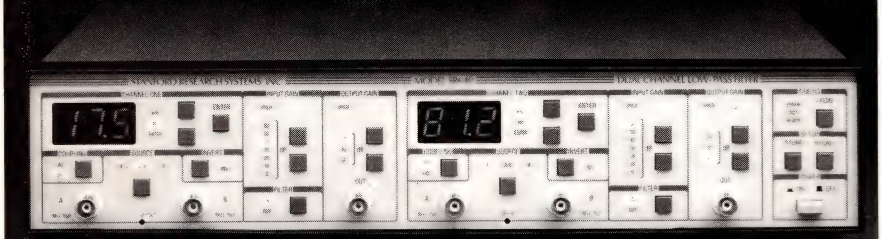
PCMCIA KIT ADDS GPIB CAPABILITY TO LAPTOPS

A laptop PC with a PCMCIA card slot can be turned into an IEEE-488.2 (GPIB) controller with the addition of the PCMCIA-GPIB interface kit. The kit includes a Type II PCMCIA plug-in board with the interface circuitry, the NI-488.2 driver software for DOS and Windows, and a 2-m custom cable terminated with a standard IEEE-488 connector. The board complies with PCMCIA Version 2.01 and is compatible with Card Services 2.0 and Socket Services 2.0. The interface works with I/O- or memory-mapped addressing and 8- or 16-bit data transfers to the PCMCIA bus. NI-488.2 autoconfigures the base address and interrupt level upon "hot insertion," so users don't have to configure jumpers or dip switches. The PCMCIA-GPIB kit is available now for $595. JN



National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730-5039; (800) 433-3488 or (512) 794-0100. **CIRCLE 869**

Low and high pass filters for real signals



SR640 dual channel low-pass filter
SR645 dual channel high-pass filter
SR650 combination high/low-pass filter
Programmable, 115 dB/octave rolloff.
$2990.

The SR640, SR645 and SR650 offer unique combinations of filter specifications, preamplifier performance, and programmability at a price far less than other instruments. Featuring two fully independent 8-pole, 6-zero elliptic filters with less than 0.1 dB p-p passband ripple and 115 dB/octave rolloff, these filters are ideal for general purpose signal processing as well as anti-aliasing for digital signal processing systems.

The GPIB and RS232 interfaces allow complete control of all instrument settings via computer. The microprocessor components are optically isolated from the filter sections to provide optimum noise performance.

Whether your needs are for laboratory benchtop filters or signal conditioning filters in data acquisition systems, the SR640, SR645 and SR650 are the natural choices.

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VLSI TESTERS OFFER RANGE OF PERFORMANCE

Three Polaris P-II VLSI logic testers let customers pick the price-performance point needed for various test applications, such as engineering characterization and test of high-end RISC, CISC, DSP, and ASIC devices. The P-IIec, which uses a Sparcstation 2 controller, comes with pin counts of 32 to 384, a 1-million-vector memory, and a 50-MHz data rate. Prices start at $690,000. The P-II 50ex and 100ex are based on the Sparcstation 10/40 tester controller. The 50ex has a 50-MHz I/O waveform rate, which can be upgraded to the 100ex's 100-MHz rate. The 50ex comes with pin counts of 64 to 384, with an upgrade option to 640. The 100ex comes with pin counts of 96 to 384, with an option for 512 pins. A 128-pin 50ex is $1.46 million; a 128-pin 100ex is $1.83 million. JN

Megatest Corp., 1321 Ridder Park Dr., San Jose, CA 95131; (408) 437-9700. **CIRCLE 870**

VISUAL BASIC SOFTWARE AIDS DATA PROGRAMMING

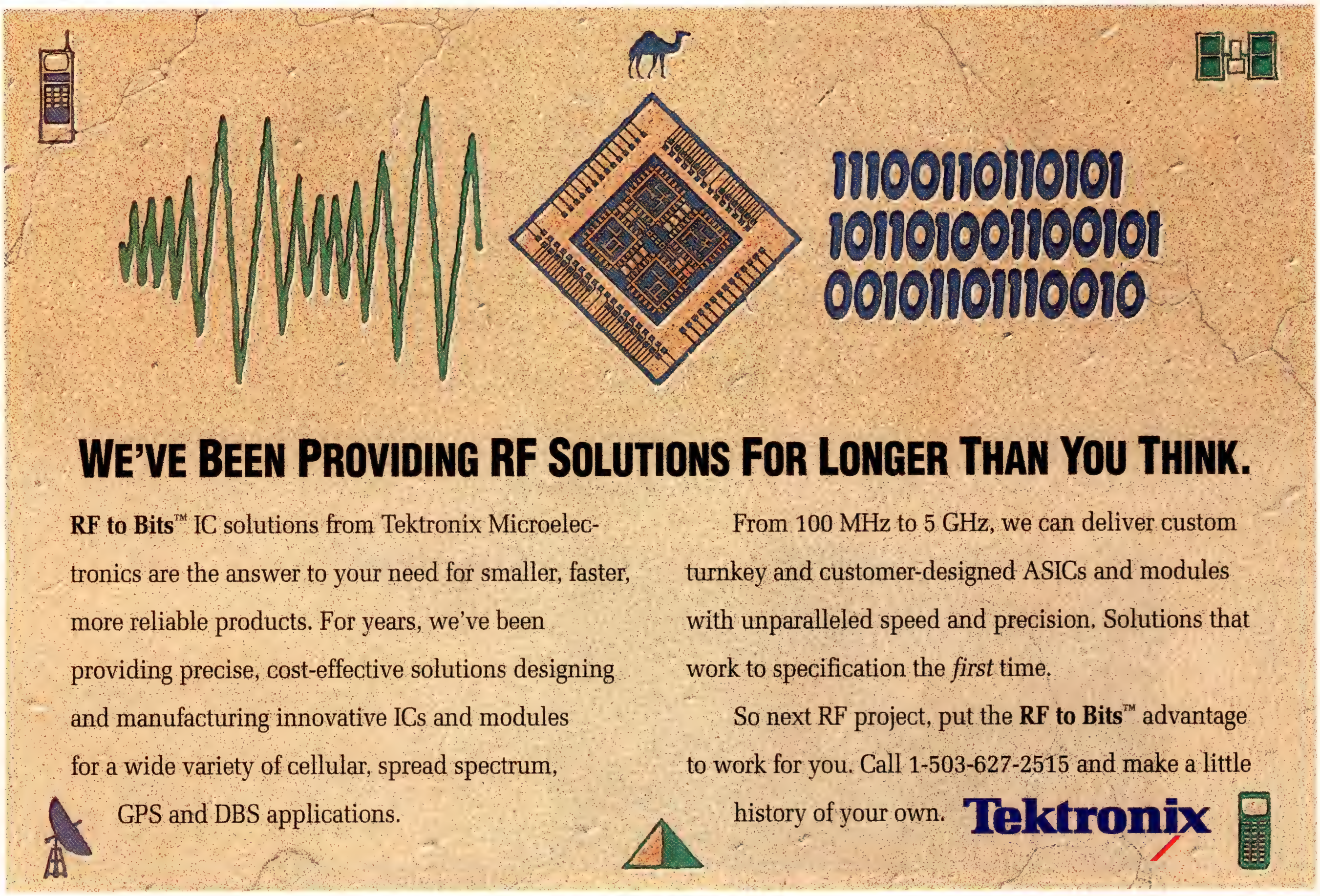
By supplying a set of Visual Basic Custom Controls, the VisualDAS software package virtually eliminates the need to write board control code when using Visual Basic for Windows to program data acquisition boards. All functions of the supported Keithley MetraByte boards' Function Call Drivers are contained in VisualDAS. Users select the appropriate parameters from a list of options or type a value for each property. Because VisualDAS is an open system, the collected data can be displayed and analyzed with the user's own Visual Basic Code or with commercially available custom controls. VDAS-800 (for DAS-800 boards) and VDAS-1600 (for DAS-1200/1400/1600 boards) cost $99 and are available from stock. JN

Keithley MetraByte, 440 Myles Standish Blvd., Taunton, MA 02780; (800) 348-0033 or (508) 880-3000. **CIRCLE 871**

TEST PLATFORM ACCEPTS ALL INSTRUMENT TYPES

The GR1000 is the latest member of the Geneva (GenRad Extended VXIbus-based Architecture) family of test systems. As an open system, the GR1000 accepts instruments from all vendors and of all types: VXIbus, IEEE-488, RS-232, and PC-based. Use of the VXIbus and the patented VXIscan switching architecture allow the GR1000 to test a wide range of applications with one system configuration. The switching architecture is modular and cableless, with ATE-like features. The system's software environment reduces test development time and the skills required. The GR1000 is available as a fully configured turnkey system or as an integration platform that users can configure on their own. A basic system costs between $50,000 and $100,000. JN

GenRad Inc., 300 Baker Ave., Concord, MA 01742-2174; (508) 369-4400. **CIRCLE 872**



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IPC-6020 SCSI-3 Wide Tester

I-TECH Corp.'s IPC-6020 SCSI-3 16-bit Wide Tester provides advanced testing capability for all SCSI devices. It is ideal for engineering and device verification.

It features an on-board high-performance SCSI processor for reduced protocol overheads, 20MB/sec data transfers, large on-board data buffers, data compare circuitry and high-level support for multi-threading, command queuing and command linking.

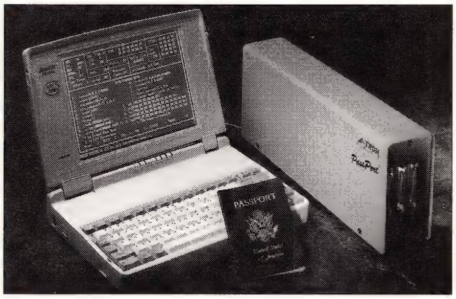
The software includes an Interactive Menu with macro keys, and a professional set of compiled test executables. An extensive library of test functions allows users to build custom tests or port SDS tests for 16-bit operation. The IPC-6020 is priced at $6,800.00

SCSI BusMonitor

BusMonitor is a small passive device used to monitor your SCSI bus activity. Each LED on the board corresponds to a specific SCSI bus control line or data line. Connectors are provided to support a wide variety of SCSI bus configurations, including 50-pin or 68-pin, single-ended or differential. Terminator power is used to drive the LEDs, making an external power supply or batteries unnecessary.

BusMonitor weighs only 3 ounces and measures 2.75" wide and 6" long. BusMonitor is priced at $200.00.

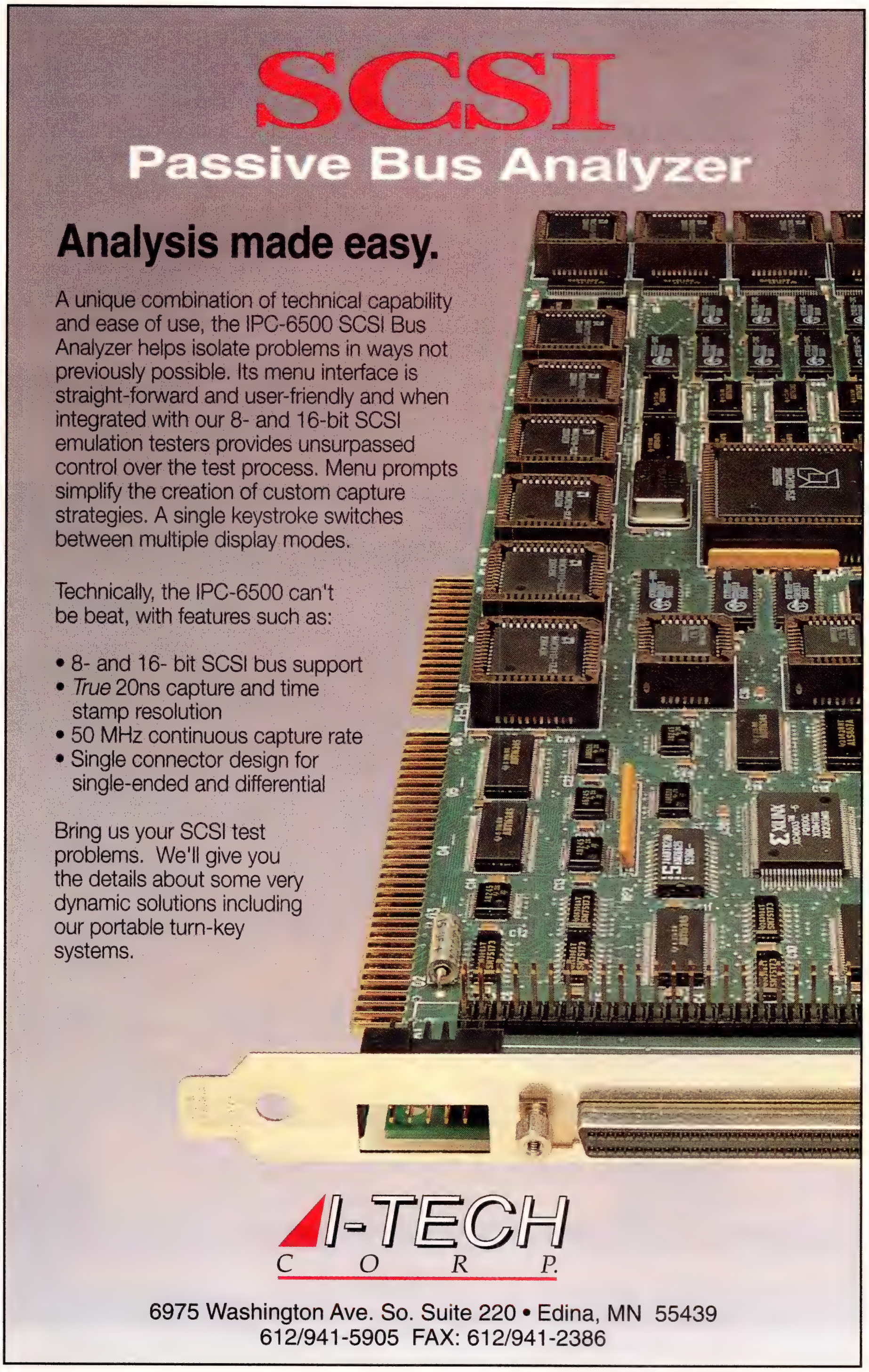
IPC-2000 ***PassPort***™



The newest in portable test equipment is now available. I-TECH's ***PassPort*** Portable Test Chassis allows the user to take along all the tools necessary for both SCSI testing and analysis. The attractive black and gray case measures only 3" wide, 6" tall and 15" long and weighs only about seven pounds when fully loaded. It can house up to two of I-TECH's full-length ISA cards and fits in a briefacase or shoulder bag. A parallel port cable connects the chassis to either a sub-notebook or a desktop PC

PassPort is ideally suited for use with I-TECH's IPC-6500 Wide SCSI Bus Analyzer, IPC-6020 Fast/Wide Emulation System and/or the IPC-5010 Fast Emulation System. All I-TECH boards retain their full functionality as if in their native environment. The IPC- 2000 is priced at $1,200.00 for the chassis only, $1,000.00 when purchased for use with other I-TECH equipment.

I-TECH Corp.
6975 Washington Ave.S.
Suite 220
Edina, MN 55439
Phone:612/941-5905
Fax: 612/941-2386



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A unique combination of technical capability and ease of use, the IPC-6500 SCSI Bus Analyzer helps isolate problems in ways not previously possible. Its menu interface is straight-forward and user-friendly and when integrated with our 8- and 16-bit SCSI emulation testers provides unsurpassed control over the test process. Menu prompts simplify the creation of custom capture strategies. A single keystroke switches between multiple display modes.

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- 8- and 16- bit SCSI bus support
- *True* 20ns capture and time stamp resolution
- 50 MHz continuous capture rate
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CIRCLE 112 FOR U.S. RESPONSE CIRCLE 113 FOR RESPONSE OUTSIDE THE U.S.

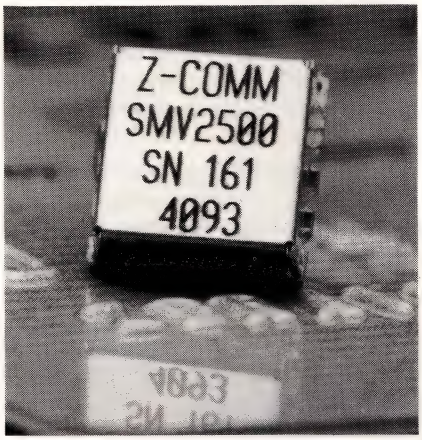
ADJUSTABLE OSCILLATOR SETS CUSTOM FREQUENCY

By placing a programmable frequency divider/multiplier and non-volatile memory into the same case as a crystal, the ICD6233 QuiXTAL can substitute for any crystal oscillator with an output frequency ranging from 0.6 to 120 MHz. Serving as a pin-for-pin replacement for standard rectangular metal-can crystal oscillators, the QuiXTAL provides convenience at a competitive price—just $4 to $6 each—and one-day turn around vs. the typical two-to-three-day turnaround for custom-frequency oscillators that rely upon custom-ground quartz crystals. Thanks to a custom chip that the company designed for the QuiXTAL, requests for custom frequencies can be satisfied the same day by just factory programming the internal nonvolatile memory to set the desired output frequency. The QuiXTAL's output can drive HCMOS or TTL interfaces and can be three-stated to allow multiple units to share the same clock line. Typical frequency accuracy is to within 0.1%, and stability is to within 100 ppm of the programmed frequency. With a 25-pF load, the 5-V powered ICD6233 draws 15 mA for a 10-MHz output, 20 mA at 50 MHz, and 25 mA for 100 MHz. Signal rise and fall times are 3 ns. CM

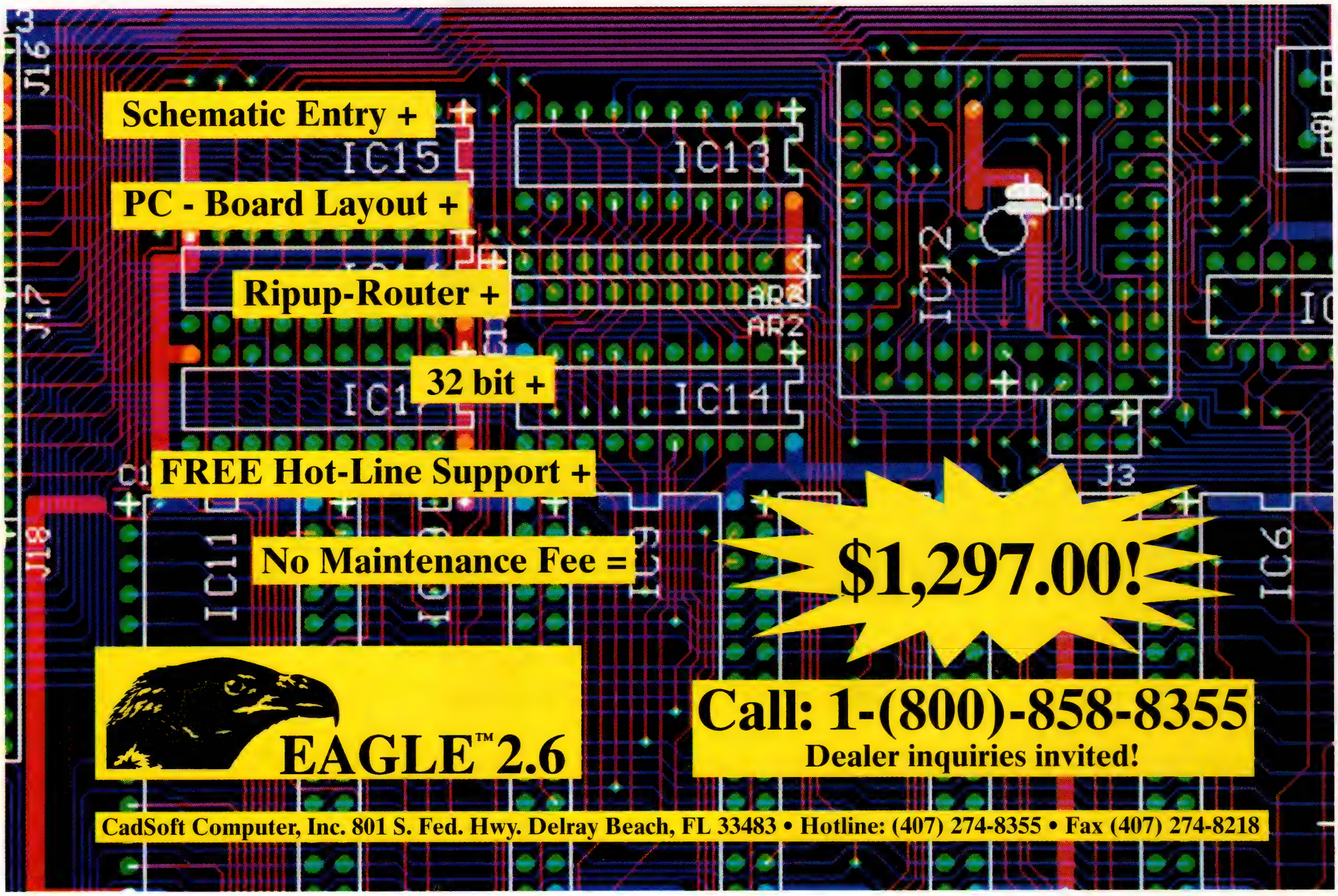
IC Designs, 12020 113th Ave. NE, Kirkland, WA 98034-9923; John Fallisgaard, (206) 821-9202.
CIRCLE 873

MINIATURE VCO SUITS WIRELESS LANS

Developed for wireless-LAN applications, the SMV2500 voltage-controlled oscillator (VCO) measures just 0.3 by 0.3 by 0.117 in., bolstering its maker's claim that it is the world's smallest VCO. Placed on a pc board in the industry-standard "credit-card" format, the device can be part of an entire transceiver module that fits handily inside portable computers. The unit oscillates between 2.4 and 2.485 GHz, operates from a 3-V dc supply, and typically draws 16 mA. Its phase noise is –85 dBc/Hz at a 10-kHz offset and its second harmonic is –20 dBc minimum. Pricing is $5.75 in lots of 100,000 with volume delivery slated for January. Samples are available at $150 each and are delivered from stock. DM



Z-Communications Inc., 9939 Via Pasar, San Diego, CA 92126; (619) 621-2700. **CIRCLE 874**



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CIRCLE 186 FOR U.S. RESPONSE
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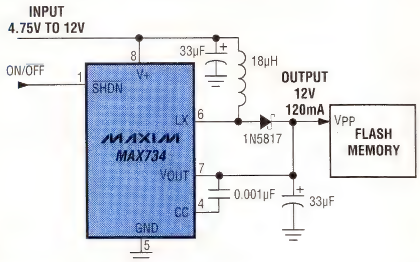
FLASH MEMORY & PCMCIA POWER SUPPLIES FOR 3V & 5V SYSTEMS

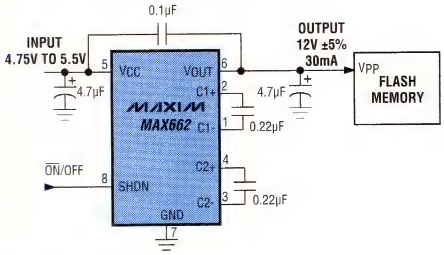
12V, 120mA 8-Pin SO Flash Programmer Fits into < 0.3in^2



The **MAX734** comes in an 8-pin SO package and delivers 120mA at 12V (+5%, -3%), guaranteed over temperature, from 4.75V to 12V inputs. The complete circuit fits into 0.3in^2. 83% efficiency at full-load and 70µA supply current in shutdown save battery life. PWM control assures fixed-frequency output ripple for noise-sensitive and communications applications. Controllable Soft-Start reduces current surges at start-up. Priced at $2.00 (10,000 pcs*). Evaluation kit available (MAX734EVKIT-SO).

* FOB, USA.

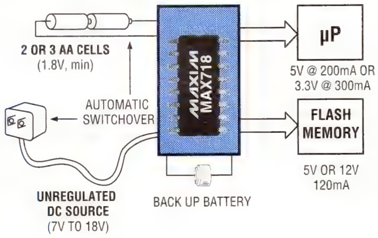
World's Lowest-Cost & Smallest Flash Programming Supply Needs No Inductors



The **MAX662** charge-pump programming supply for flash memories fits in 0.2in^2 and uses only low-cost capacitors to provide a regulated 12V ±5% output. Guaranteed output current is 30mA for 4.75V to 5.5V inputs. No-load current is 320µA, which drops to 70µA in shutdown. The MAX662 comes in 8-pin DIP and SO packages and is priced at $1.85 (10,000 pcs*). Evaluation kit is available (MAX662EVKIT-SO).

* FOB, USA.

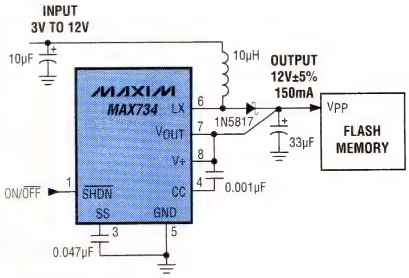
Dual-Output Step-Up Converters Program Flash Memory and Power Microprocessor



The **MAX717-MAX721** dual-output converters step up from as low as 1.8V. They have 87% efficiency and 60µA supply current (20µA in shutdown), and come in 16-pin narrow SO packages. You can set the main output to 3V, 3.3V, or 5V, and deliver 200mA. The auxiliary output delivers 5V or 12V at 120mA using a low-cost external N-channel switch. Features include low-output warning, automatic switchover between battery and wall-adaptor power, and back-up battery switchover to keep memory and clock alive. All outputs are logic-controlled. Priced at $5.95 (1,000 pcs*). Evaluation kit available (MAX718EVKIT-SO).

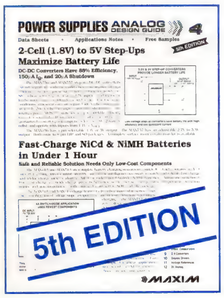
* FOB, USA.

Convert 3V Inputs to 12V, 150mA Outputs to Program Flash Memories



The **MAX734** step-up converter provides 12V output operation from inputs as low as 1.9V, when configured for bootstrapped operation. For 3V inputs, typical output power is 150mA at 12V±5%. The entire circuit fits into 0.3in^2 and uses only a diode, a 10µH inductor, and four capacitors. Battery-saving features include 80% efficiency, 70µA shutdown supply current, and controllable Soft-Start to reduce surge currents at start-up. Priced at $2.00 (10,000 pcs*).

* FOB, USA.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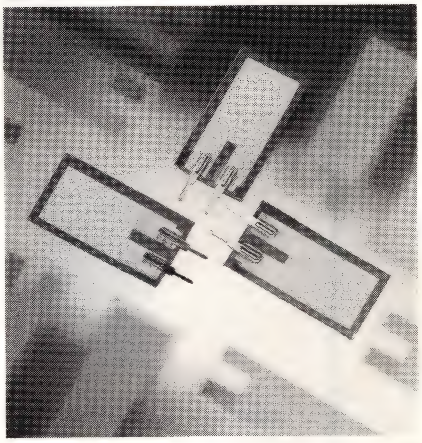
CIRCLE 208 FOR U.S. RESPONSE **CIRCLE 209 FOR RESPONSE OUTSIDE THE U.S.**

PIEZO-FILM SENSORS OFFER EASY MOUNTING

A low-cost line of piezo-film vibration sensors features two solder pins for mounting ease and flexibility. The LDT-0 Series sensors are low-profile, compact devices that are well-suited for applications in automotive alarms, home-security systems, portable alarms, and coin counters. The sensors are made of rugged, lightweight piezoelectric polymer film that isn't fragile like piezo ceramics. They feature two hand-solderable solder pins on 0.2-in. centers for electrical and mechanical connection to pc boards. Because of the film's low mechanical Q, the sensors can be used in broadband applications that have low mechanical resonances. They also eliminate the environmental problems and false alarms associated with mercury sensors. Pricing is from $0.50 to $0.75 each, depending on quantity. Delivery is from stock. DM



AMP Sensors, P.O. Box 3608, Harrisburg, PA 17105-3608; (215) 666-3500. **CIRCLE 875**

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With the continuing downsizing of equipment increasing the sensitivity of circuits with respect to thermal energy, it's becoming more difficult to specify the correct rated current of a fuse. Each of the seven kits in Schurter's family contains fuses in a range of rated currents from a specific fuse series. The kits allow engineers to correctly select the value needed to safely and reliably protect the circuit. Kits include 5-by-20-mm fuses with low- and high-breaking capacities, 125- and 250-V microfuses and fuseholders, and 63- and 250-V SMT fuses and fuseholders. Kits are refillable for maintenance uses. Pricing ranges from $120 to $289. Delivery is from stock to six weeks. DM

Schurter Inc., 1016 Clegg Ct., Petaluma, CA 94954; Michele Prodan, (800) 848-2600, ext. 150. **CIRCLE 876**

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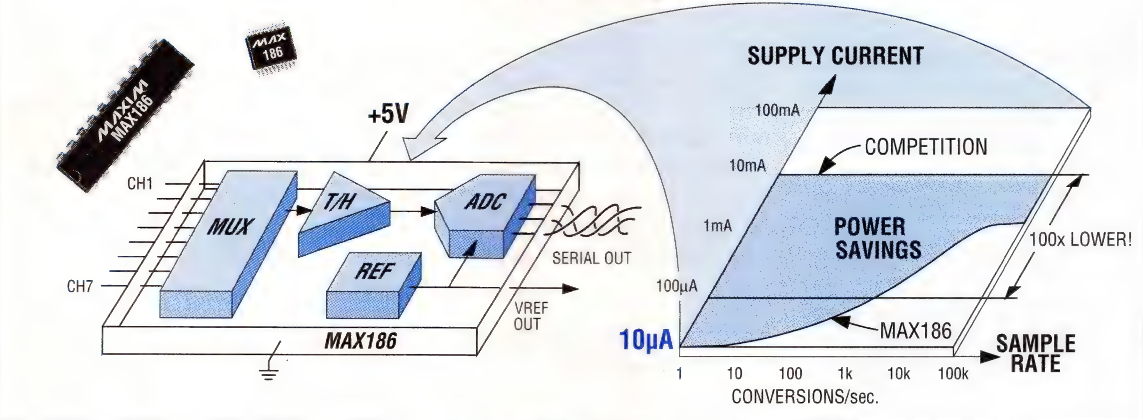
Save Power & Space!



Choose Your 5V µPower 12-Bit ADC

Part #	Output Format	Input Channels	Ref	Sample Rate	Power Down (max)	Pins*	Price†	Call For EV Kit:
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MAX187	Serial	1	INT	75ksps	10µA	8	$7.45	
MAX188	Serial	8	EXT	133ksps	10µA	20	$8.45	MAX186EVSYS
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** Package Options Include DIP, SOIC, and SSOP*
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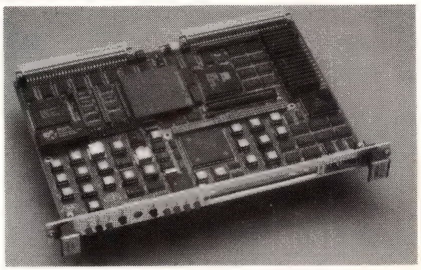
VME64 SINGLE-BOARD COMPUTER BOASTS ADDED FLEXIBILITY



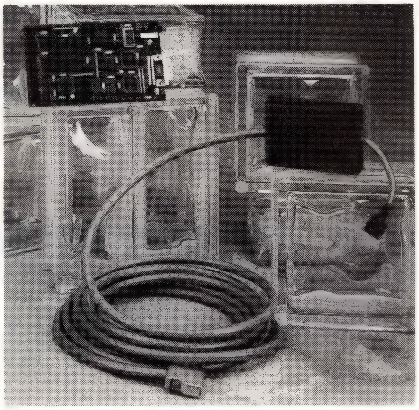
Single-board computers (SBCs) once filled an entire 6U VMEbus board. For additional functionality, such as I/O, or memory, a separate board was needed and the two communicated over the VMEbus. Now, with the level of integration constantly increasing, multiple functions fit directly onto the SBC. The PT-VME151A, from Performance Computer, is an example of such a multifunction SBC.

The PT-VME151A, based on a 68040 microprocessor, can handle a 64-bit interface, and 10 Mbytes/s over a fast SCSI-2 port. The SCSI port also features active on-board termination to maximize data integrity. On-board memory can reach 64 Mbytes. The modular memory design simplifies field upgrades. Even more functions are available through a mezzanine interface. Such modules can operate as a slave or a DMA device. Multiple real-time operating systems are supported as well as a debug and monitor software package. Available now, the PT-VME151A is priced at $1995 in quantities of 100.

Performance Computer, *315 Science Pkwy., Rochester, NY 14620; (716) 256-0200.* **CIRCLE 877**

■ *RICHARD NASS*

SYSTEMS HELP DEBUG DSP TARGETS



Designed for Sun SparcStation and compatible platforms, the Brahma-JTAG and -MPSD systems supply either a JTAG interface for a Texas Instruments TMS320C40 processor or an MPSD interface for the TI TMS320C30 and TMS320C31 floating-point DSP chips. As a result, users can debug hardware and software that's embedded in a target system. Both serial interfaces permit external memory to be read from or written to and also offer complete control of the target system, including register modification and breakpoints. When used with a TI C compiler and assembler, the debugger supplies both C- and assembly-level debugging. Breakpoints can be set in either mode, and execution can be single-stepped in C or assembly modes. Variables can be watched and execution time of functions and code sections can be benchmarked. The interface systems sell for $4500 each. A combination of the two systems is available for $5495. RN

Sonitech International Inc., 14 Mica Ln., Wellesley, MA 02181; (617) 235-6824. **CIRCLE 878**

OPERATE SIX X TEMINALS FROM SPARCSTATION 10

Using the SXT100 graphics board, users can expand a SparcStation 10 workstation into a server that supports up to six monitors that can operate as X terminals. The SXT100 basically consists of a single-slot SBus-based frame buffer, a mouse, and a keyboard. Monitor resolutions up to 1152 by 900 pixels are supported. The board conforms to the monitor timings established by the Video Electronics Standards Association (VESA). Prices for the SXT100 start at $795. RN

Integrix Inc., 1200 Lawrence Dr., Suite 150, Newbury Park, CA 91320; (805) 375-1055. **CIRCLE 879**

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Maxim's new MAX509 combines four 8-bit DACs with four rail-to-rail output buffers in a tiny Shrink Small-Outline Package (SSOP) that occupies less than 0.1 square inch of board space. For maximum flexibility, each DAC has its own reference input, which accepts any DC or AC voltage up to and including V_{DD} and V_{SS}.

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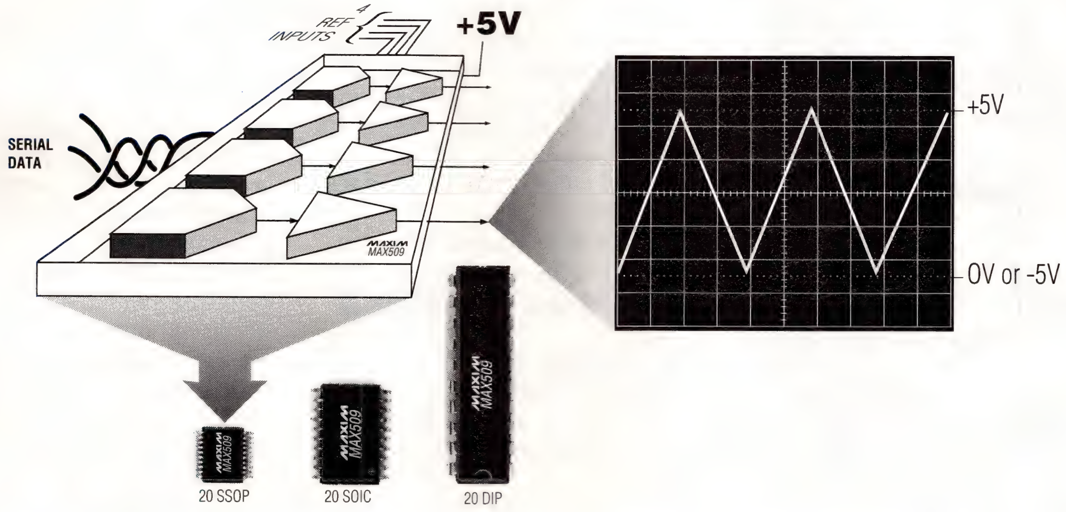

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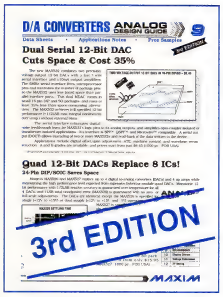
- ◆ **Serial Output for Daisy-Chaining**
- ◆ **Parallel Version Also Available (MAX505)**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PSM ELIMINATES DAMAGE IN FUTUREBUS+ SYSTEMS

The up and down power sequence of the four Futurebus+ backplane voltage rails can be controlled by the Power Sequencing Module (PSM). This helps to eliminate the possibility of catastrophic device damage resulting from a reverse current flow in systems that employ both 3.3- and 5-V components. The PSM gets connected in parallel with the main input and the power supply. Auxiliary inputs can also be enabled, but the outputs of each voltage rail can only be enabled in the correct sequence defined by the setup of the PSM. Voltage-present indicators, power up and down switches, and a series of status LEDs are mounted on the module's front panel. The PSM is available now for $150. RN

BICC-VERO Electronics Inc., 1000 Sherman Ave., Hamden, CT 06514; (800) 242-2863. **CIRCLE 880**

VME SBC HOLDS 486, RUNS DOS

The 4, 16, or 32 Mbytes of DRAM that come with the VME-1486 embedded PC board are sharable with other boards on the VMEbus. The single-board computer is built with a 486 microprocessor, ranging in speed from 25 to 66 MHz. Other features include an on-board Ethernet port, Super VGA video support, a fully buffered ISA bus interface, and jumperless configuration using software switches. The board can run DOS, Windows, OS/2, or the Lynx real-time OS. The VME-1486 starts at $2242.50, in lots of 100. RN

Logical Design Group Inc., 6301 Chapel Hill Rd., Raleigh, NC 27607; (919) 851-1101. **CIRCLE 881**

DATA-ACQUISITION BOARD COSTS $295

To respond to the need for affordable PC-compatible industrial data acquisition and control, the SAT-V40 comes in at just $295. The DOS-compatible single-board computer is built with an 8-MHz NEC V40 processor, three serial ports, 24 parallel I/O lines, and an optional eight-channel 12-bit analog-to-digital converter. The a-d converter can be configured through software for unipolar or bipolar operation and single-ended or differential inputs on a per-channel basis. Also, additional I/O is available using PC/104 modules. The SAT-V40 measures 4.5 by 7 in. and consumes 1.7 W.

WinSystems Inc., 715 Stadium Dr., Suite 100, Arlington, TX 76011; (817) 274-7553. **CIRCLE 882**

STD 32 BOARD LOADED WITH I/O

Built to the STD 32 specification, the VL-12CT97 I/O board offers a 10-μs analog-to-digital converter and eight differential or 16 single-ended input channels with 16-bit resolution and ±5- or ±10-V ranges. Two 12-bit channels are used for analog output. The board's 16 bidirectional digital I/O lines are configured as open-collector outputs with read-back. Each channel can be individually programmed to act as an input or output. Maskable interrupts are independently available from the analog and digital input sections. An interrupt can be generated at the end of an analog input conversion, or generated by up to four digital inputs changing state. The VL-12CT97 sells for $685. A lower performance version, the 12CT96, is also available. RN

VersaLogic Corp., 3888 Stewart Rd., Eugene, OR 97402; (800) 824-3163. **CIRCLE 883**

MULTI-STAGE BOARD HANDLES 6.44 GOPS

A multi-stage vector processor board that continuously processes complex data at 40 MHz can handle 6.44 GOPS. The 9U VME CRCFV1M40-64K-C6 can perform one million point convolutions on a 48-bit complex data stream at a minimum sustained data rate of 40 million samples/s. The board features up to six cascaded sets of the Sharp LH9124/LH9320 block floating-point DSP chips, depending on the amount of processing power required. In addition, multiple boards can be cascaded for larger applications. Available now, prices for the CRCFV1M40-64K-C6 range from $39,750 for three stages to $74,250 for six stages. RN

Catalina Research Inc., 985 Space Center Dr., Suite 105, Colorado Springs, CO 80915; (719) 637-0880. **CIRCLE 884**

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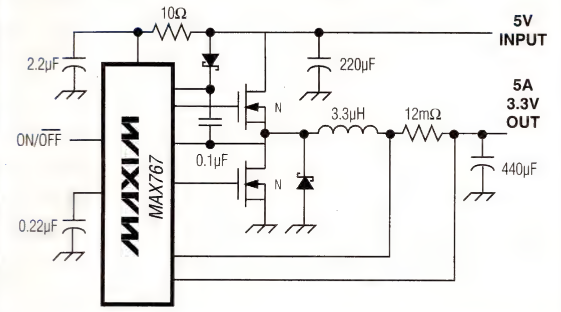
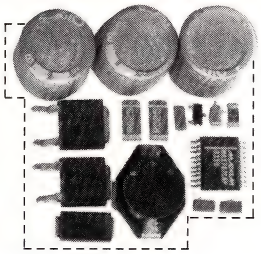
  - **5.0 Amp, L=3.3µH**
  - **7.0 Amp, L=2.2µH**
  - **10.0 Amp, L=1.5µH**

5A APPLICATION CIRCUIT



5A SUPPLY COMPONENTS SHOWN ACTUAL SIZE



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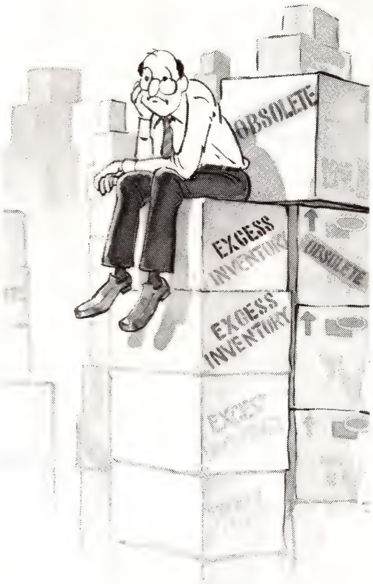

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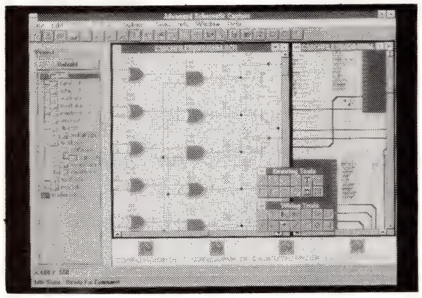
PCB TOOLS INCREASE AUTOMATION LEVEL

The latest release of Protel Technology's pc-board design tools offer higher levels of automation. Advanced Schematic 2.0 for design entry has a guided wiring feature that speeds component wiring by snapping to electrical hot spots during wire placement, then automatically making connections when the user clicks a button. Project-level global editing automatically changes attributes of schematic design objects throughout a mulitsheet hierarchical project. Advanced PCB 2.0 is a board-layout system that includes forward-annotation to communicate design changes from Advanced Schematic. The board-design environment is further enhanced with Advanced SB Route, a shape-based gridless autorouter. Advanced Schematic 2.0, Advanced PCB 2.0, and Advanced SB Route run on a PC under Windows. Prices are $995, $2795, and $9900, respectively. LM



Protel Technology Inc., 4675 Steven Creek Blvd., Suite 200, Santa Clara, CA 95051-6764; (800) 544-4186 or (408) 243-8143. **CIRCLE 885**

EMI TOOL FORECASTS RADIATION PATTERNS

The Quiet signal-integrity tool accurately locates and quantifies EMI on backplanes, motherboards, and multichip modules. It automatically predicts total radiation patterns from transmission-line simulation, performing both what-if analyses and full-board screening. Transmission-line simulation technology simulates nets and computes the radiation from each net segment. The tool then produces a full-board radiation plot and generates a report of net-by-net contributions. Users can define one or more antenna positions to determine power spectra at specific points. Quiet will have production shipments this quarter. LM

Quad Design Technology Inc., 1385 Del Norte Rd., Camarillo, CA 93010; (805) 988-8250. **CIRCLE 886**

PCB DESIGN SYSTEM HAS JUST ONE INTERFACE

A front-to-back pc-board design system called Run meshes all necessary functions under one graphical user interface. The system is composed of modules that perform schematic capture, component layout, digital and analog simulation, and routing. A proprietary technology called Real Annotation allows users to change the board layout or route path while creating the schematic, and vice-versa. Because Run uses a single database, component-placement, test points, and design rules can be predefined. During layout, users can immediately see pins, gates, packages, and component names on the schematic and route layer. Run supports flex circuits and conventional pc boards with up to 31 layers. All modules are shipping now for Macintosh computers. Prices are $975 for the schematic capture to $20,500 for the compete system. LM

microCADpartners, 3312 W. 132nd St., Burnsville, MN 55337; (612) 895-8236. **CIRCLE 887**

INTERFACE LINKS ASIC AND DSP TOOLS

A software interface links the IC design tools from Compass Design Automation with the Signal Processing WorkSystem (SPW) DSP design system from Comdisco Systems. The interface is available as an option to Compass' Navigator top-down design tool suite. With the interface, users can start by architecting, simulating, and optimizing at the system level with SPW. Then, they use the Compass datapath-synthesis and -compiler tools to create physical implementations. In addition, the Compass DSP library contains a wide range of complex design elements. The DSP Design Option to the Navigator Series of tools is shipping now for Unix workstations. Its $20,000 price tag includes the interface and the DSP behavioral library. LM

Compass Design Automation Inc., 1865 Lundy Ave., San Jose, CA 95131; (408) 433-4880. **CIRCLE 888**

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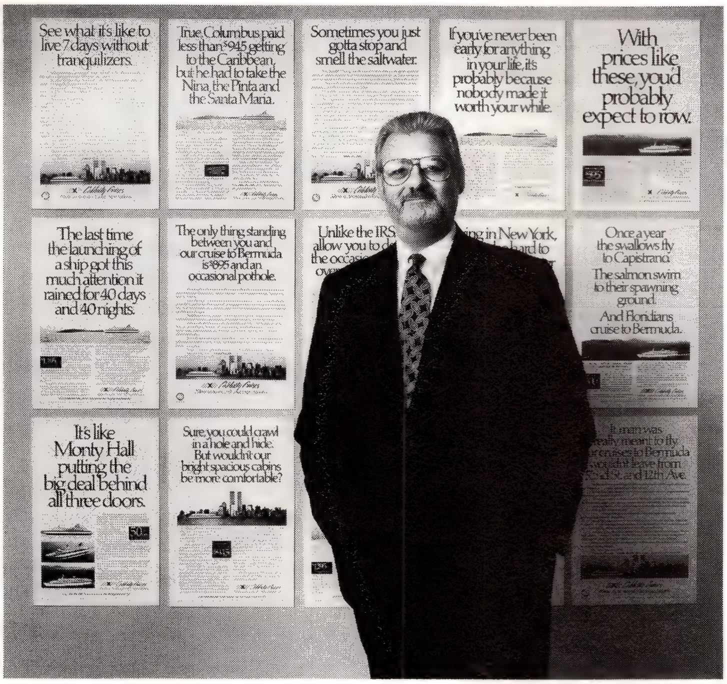
See what it's like to live 7 days without tranquilizers.
True, Columbus paid less than $945 getting to the Caribbean, but he had to take the Nina, the Pinta and the Santa Maria.
Sometimes you just gotta stop and smell the saltwater.
If you've never been early for anything in your life, it's probably because nobody made it worth your while.
With prices like these, you'd probably expect to row.
The last time the launching of a ship got this much attention it rained for 40 days and 40 nights.
The only thing standing between you and our cruise to Bermuda is $895 and an occasional pothole.
Once a year the swallows fly to Capistrano. The salmon swim to their spawning ground. And Floridians cruise to Bermuda.
It's like Monty Hall putting the big deal behind all three doors.
Sure, you could crawl in a hole and hide. But wouldn't our bright spacious cabins be more comfortable?

Photo: Frank Moscati

Al Wallack, Sr. VP Marketing, Celebrity Cruises, after returning from having his hearing checked.

"A great time to introduce a new luxury cruise line. The economy was in a slump, and the competition was on the rise.

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To make a long story short, two-thirds into the newspaper phase, Celebrity's ships were just about full to the end of the season. With so little left to sell, we all agreed to hold the radio and TV and save the remainder of the budget.

In roughly two years Celebrity became the number one cruise line from New York to Bermuda.

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This advertisement prepared by Korey, Kay & Partners, New York.

DESIGN KIT CREATES PENTIUM-BASED PCBS

The first in a planned series of high-speed board design kits from Mentor Graphics helps engineers create pc boards built around the Intel Pentium processor. The kit is part of the company's Electronic Design Guide for Excellence (EDGE) program, which enables Mentor to partner with semiconductor companies and provide design kits for leading-edge processor technologies. The Pentium design kit, which is used with Mentor's Board Station 500 pc-board design environment, will help engineers manage trade-offs and meet performance requirements. The kit supports design capture, physical layout, and thermal and electrical analysis. It includes logic symbols, mapping files, geometry, and signal-integrity I/O models. There's also thermal models, reference layout for the core logic, and electrical rules such as flight and skew timing constraints.

A multimedia tutorial walks engineers through a design example illustrating how to implement a board using the design kit. The design example is a full schematic and layout for an EISA motherboard that's included in Intel's Open Design Guide. The Pentium processor high-speed board design kit is free of charge to all Mentor's Board Station 500 customers. Call the company for additional information.

Mentor Graphics Corp., 8005 S.W. Boeckman Rd., Wilsonville, OR 97070-7777; (503) 685-7000.
CIRCLE 889

ANALYSES DETECT EMI AND CROSSTALK

Version 2.5 of the MSC/EMAS finite-element analysis system helps engineers detect electromagnetic interference (EMI) and crosstalk problems in high-frequency systems. The program addresses a wide variety of applications, and an intelligent user interface supplies only the choices needed for the specific application being analyzed. For example, MSC/EMAS for EMI and Crosstalk quantifies radiation effects, shielding, and absorption properties; electronic device performance in terms of capacitance, conductance, inductance, and resistance (CGLR) matrices; and can reduce electromagnetic simulation results into a Spice net list for use with Spice models.

Similarly, MSC/EMAS for Antennas calculates antenna input impedance, directivity, polarization, and radiation patterns while providing a detailed picture of field behavior. It also allows antenna designers to analyze, without prototyping, complex systems that are typically difficult to study using traditional measurement and numerical techniques. In addition, the next version will support analysis of radiators in antenna arrays. MSC/EMAS Version 2.5 is available now. It runs on a variety of platforms, including Unix workstations and DEC VAX computers. Call the company for pricing and additional information. LM

The MacNeal Schwendler Corp., 815 Colorado Blvd., Los Angeles, CA 90041-1777; (213) 258-9111. **CIRCLE 890**

SOFTWARE HELPS USERS PROJECT PRODUCT COSTS

Version 3.0 of the SEER-H software helps engineering teams with project-cost analysis and estimation. The new version expands the product's ability to provide detailed labor-hour and material cost estimates for hardware development and production programs, from simple board-level products to complex aerospace structures. SEER-H determines the technology level being used in any particular project by describing component density, speed, types of circuitry, and the level of IC integration. It also provides details and analysis of material and labor costs affected by decisions to build, or buy and integrate. Calculations are based on known and proven technical and program parameters that drive hardware design and development costs. SEER-H 3.0 runs on DOS platforms under Windows, and also on Macintosh computers and Sun workstations. The Windows version costs $21,700 for an annual site license. Macintosh and Sun licenses are 10% and 20% higher, respectively. LM

SEER Technologies, P.O. Box 90579, Los Angeles, CA 90009; (310) 670-3404. **CIRCLE 891**

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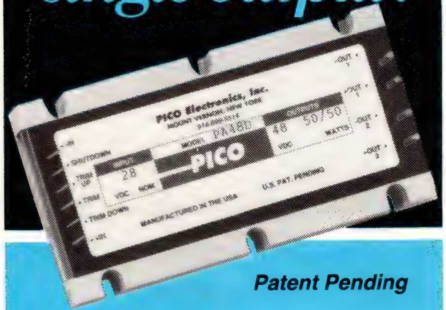

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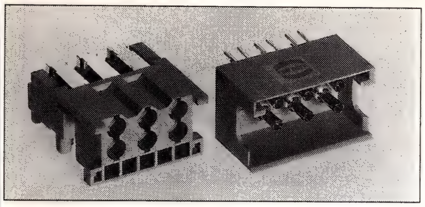
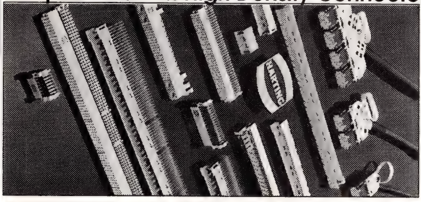


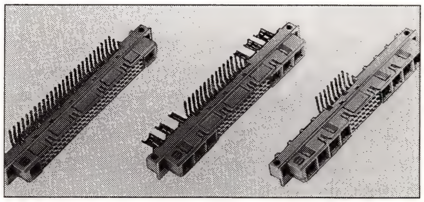
Designed for high speed data transfer rates. Can be used in the IEC 1076-4-2 2.5mm High Density connector system, har-pak®. Provides more space efficiency, high frequency capability, easy handling, low applied cost and application with current equipment practice and emerging metric equipment practices. Designed for PCB termination on both daughtercard to backplane connection; allowing users to bring signal directly into the backplane without a cable transition.

CIRCLE 282

har-pak® 2.5 MM High Density Connector system



Developed for backplane and daughterboard applications in modern rack systems. The 5 row 2.5 mm connector design offers solderless PCB terminations, optimum utilization of space, three dimensional modularity, high contact density, EMI protection, and the ability to double-side surface mount components on daughter cards without loss of a 15 mm card pitch. The har-pak connector system permits using a three dimensional 2.5 mm grid. With the exceptional capabilites of the connector, only one connector style is required to solve your power, signal, ground, and high data rates; simplifying the design and manufacturing of future systems. The compliant pin technology utilizes the same 1 mm plated through hole standard for many DIN 41 612 compliant pin technologies. The consistency in design uses the many years of manufacturing and design experience already available. These attributes combined can lead to new advancements n board-level designs: 15 mm card pitch with double-sided surface mounted daughter cards, butterfly or mid-plane techniques, modular design both horizontally and vertically, low number of system components, combination with other standardized packaging systems, and lower applied costs. **CIRCLE 283**



COMPLIANT PIN DIN 41612-TYPE M INVERSE CONNECTORS

HARTING'S compliant pin Inverse Type M DIN 41612 Eurocard connectors allow-continued development of backplane technology using solderless termination and double-side surface mounting. Applications include telecom, medical and high speed computers. Connector-cavities accommodate the DIN 41626 high voltage, power, coaxial or fiber optic contacts. Connector arrangements can accommodate 2 to 10 special purpose contacts and 78 to 6 standard contacts respectively. Compatible with HARTING male press-In tooling without modification, it can be delivered with special press-In Inserts to allow use of 'Flat Rock" or simple flatpress-in dies. **CIRCLE 284**

'har-mik®', NEW MINATURE CONNECTORS FROM HARTING ELEKTRONIK

New, comprehensive range of miniature connectors, the 'Pin and Socket' I/0 connectors Series 60.01/02/03/04, are designed to meet the requirements of internal and external connections of the future.

- Reduced size: contact pitch of 1,27 mm
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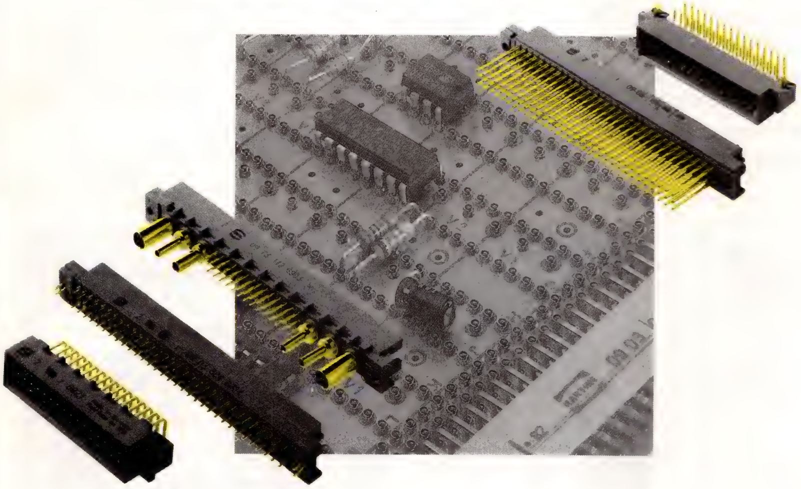
- Polarized by D shape
- Coding: without contact loss
- Locking device:
  quick latch for S.C.S.I /RS 232 E applications.
  Jackscrew for I.P.I/HI.P.P.I applications
- Male and female IDC versions for discrete wire 28 to 30 AWG
- Male and female connectors with straight and angled solder pins
- Many connector sizes: from 20 to 100 ways

CIRCLE 285

Gds A DIN connectors

Efficient



HARTING is a hallmark of innovation and reliability worldwide – throughout the electronics industry and in the switchgear sector.

With the Gds A standard DIN 41612 printed circuit connectors, HARTING not only meets top requirements in terms of precision and quality but also makes a contribution to progress in the field of automation. The Gds A connector is mounted and fixed to the PC board in a single procedure. Components, solder pins and the fastening clips of the connector can thus be soldered in a single process.

With a comprehensive range of connectors, HARTING offers perfect solutions for all applications.

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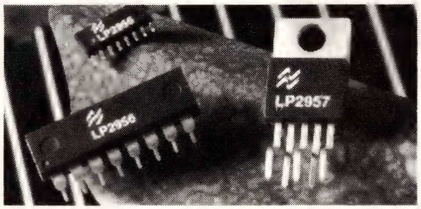
WÄCHTER BREMEN

CIRCLE 106 FOR U.S. RESPONSE **CIRCLE 107 FOR RESPONSE OUTSIDE THE U.S.**

DUAL LOW-DROPOUT LINEAR REGULATOR HANDLES 250 MA



While not extinct, the classic three-terminal linear regulator hardly resembles its offspring. Additional features and functions have sprouted and most new models combine minimum dropout voltages with similarly low quiescent currents.

National Semiconductor has combined all of these attributes in the first dual low-dropout regulator (LDO). The LP2956's "main" LDO handles 250 mA while offering a maximum dropout voltage over temperature of 800 mV. The auxiliary LDO's output provides 75 mA and its maximum dropout voltage at that current runs 850 mV. Maximum dropout voltage over temperature for the main and auxiliary outputs, while providing 1 mA to a load, run 150 and 300 mV, respectively. Quiescent current (I_Q) increases as the load current from each output increases. For example maximum I_Q runs 280 μA with 1 mA flowing from the main output and 100 μA from its companion, but it rises to 33 mA with 250 mA from the main and 1 mA from the auxiliary output.

Additional features include a comparator, which senses if the main output goes out of regulation by more than 5%. If it does, an error-output-flag pin goes low. The main output can also be shut down with an external signal, at which time I_Q drops to 200 μA if there is no load on the auxiliary output. The auxiliary output is always on and can be used to power sense or memory circuits when the main output is shut down. The chip contains an additional undedicated open-collector-output comparator, which may be used for low-battery detection, fault detection, or to send a reset signal to a microprocessor. Each output can be set at voltages from 1.23 to 29 V with an external resistive divider, or to a 5-V via pin tied to the chip's divider.

The LP2956 comes in 16-pin SOICs and DIPs. A companion, the LP2957, has a fixed 5-V output and is rated at 250 mA. It also sports an out-of-regulation flag and a shutdown pin. It comes in a five-lead TO-220 package with staggered leads. In lots of 1000, the LP2956 goes for $2.57 each; in like lots, its cohort costs $2.35.

National Semiconductor Corp., *2900 Semiconductor Drive, P.O. Box 58090, M/S 16.300, Santa Clara, CA 95052-8090; Mark Kachmarek, (408) 721-7509* **CIRCLE 892**

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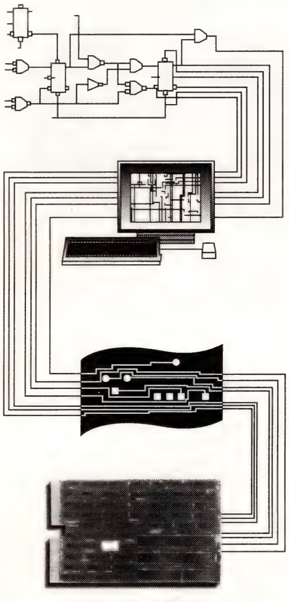

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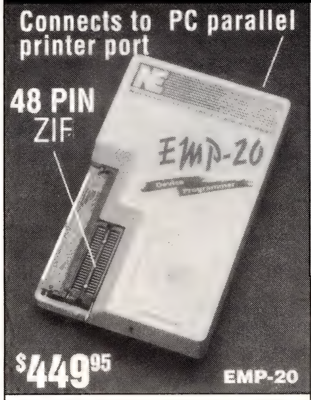
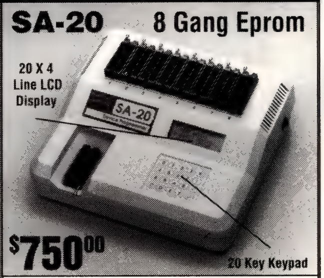
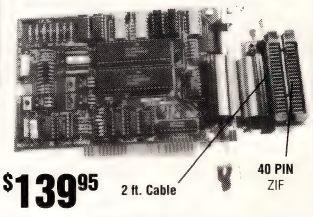
CIRCLE 182 FOR U.S. RESPONSE
CIRCLE 183 FOR RESPONSE OUTSIDE THE U.S.

Device Programmers





PB-10 Internal Card for PC



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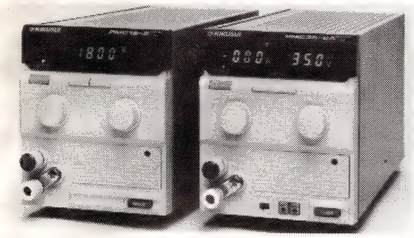
CIRCLE 222 FOR U.S. RESPONSE
CIRCLE 223 FOR RESPONSE OUTSIDE THE U.S.

COMPACT DC SUPPLY IS EASY TO USE

Two highly visible digital meters for independent monitoring of output voltage and current are featured in the PMC-A Series dc power supplies. These meters are visible even in bright lighting. For easy operation, all calibration pots and remote-control switches are located on the front panel. Models are offered with output-voltage ranges of either zero to 18 V dc with output-current ranges of zero to 1, zero to 2, or zero to 3 A; or voltages from zero to 35 V dc with output-current ranges of zero to 0.5, zero to 1, or zero to 2 A. All can continuously supply maximum current at maximum voltage, and all can be used as benchtop supplies or rack-mounted with an optional adaptor. Pricing starts at $379 each. DM



Kikusui International Corp., 1980 Orizaba Ave., Signal Hill, CA 90804; Joe Engler, (310) 986-1677. **CIRCLE 893**

AC-POWER CONTROLLER CORRECTS POWER FACTOR

Eliminating the need for power-factor-corrected dc power supplies, the PFC2041 controller combines power-factor correction with ac-power distribution in one efficient system. The unit is a voltage-selectable, single-phase, 47-to-63-Hz system that can be operated at 90 to 132 V ac or 180 to 270 V ac. Two switched sections of six IEC 320 outlet receptacles are mounted on the front panel with a 4-second delay between the two sections. The system comes with two remote-I/O connectors for remote power-on/off and emergency shutdown for a mechanical, electronic, or thermal-switching device. All applicable European and North American safety standards are met by the system. Optimum operating range is from 50 to 100% of rated power, which is 1500 W. Total output power is 2 kW, of which 1.5 kW is power-factor corrected to 98%. The PFC2041 controller goes for $1899. Call for delivery information. DM

Pulizzi Engineering Inc., 3260 S. Susan St., Santa Ana, CA 92704-6865; Pete Pulizzi, (714) 540-4229. **CIRCLE 894**

150-W CONVERTERS PROVIDE FLEXIBILITY

Two remote-shutdown pins, one referenced to the primary side of the transformer and the other to the secondary side, give the MM-PAK 150-W dc-dc converter a degree of design flexibility that some competing product do not have. The dual shutdown pins enable designers to mix and match MM-PAK converters with other modules that have either primary- or secondary-side shutdown. The units are half the size of Powercube's 300-W HD-PAK converters and deliver 150 W of output power at an 85°C baseplate temperature. The fixed-frequency, 250-kHz converters also feature parallel operation (N+1 redundancy); control functions such as DC OK, remote sense, temperature and current monitor, and synchronization; and low output ripple. Available output voltages include 2.1, 3.3, 5, 12, 15, 24, 28, and 48 V dc with wide input ranges of 36 to 76 V (48 V dc nominal) and 200 to 400 V dc (300 V dc nominal). Pricing is $100 in lots of 100 with availability scheduled for the first quarter of 1994. DM

Powercube Corp., Eight Suburban Park Dr., Billerica, MA 01821; Roy Allman, (508) 667-9500. **CIRCLE 895**

SPONGE-METAL NICDS UP CAPACITY BY 80%

Up to 80% more energy capacity than conventional cells is exhibited by a line of sponge-metal nickel cadmium batteries. The SM80 batteries are 4/5A cylindrical types with a capacity rated at 1.3 Ah. Features include a one-hour recharge capability, stable discharge characteristics, and high reliability. Applications include communication systems, office-automation equipment, and any others in which high energy density and small size matter. Call for pricing. DM

Panasonic Industrial Co., Battery Sales Group, Two Panasonic Way, Secaucus, NJ 07094; (201) 348-7000. **CIRCLE 896**

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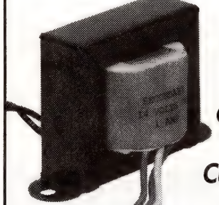

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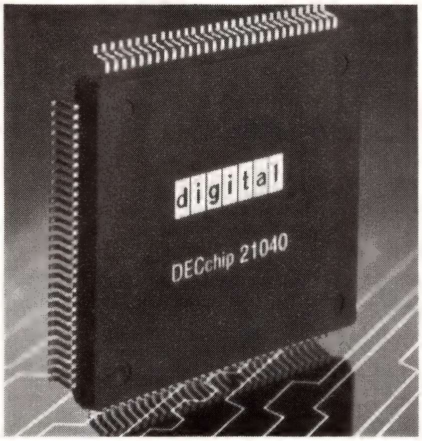
CIRCLE 166 FOR U.S. RESPONSE
CIRCLE 167 FOR RESPONSE OUTSIDE THE U.S.

PCI-ETHERNET CONTROLLER MAXIMIZES THROUGHPUT



A highly-integrated Ethernet controller chip that includes the high-performance peripheral component interconnect (PCI) bus interface provides a glueless connection to PC, Alpha, NT, and Power PC-based platforms. The high-speed interface, coupled with the ability of the DECchip 21040 to support full-duplex operation and two large on-chip FIFO buffers (256 bytes each) for the transmit and receive channels, lets the DEC controller maximize data throughput while keeping system logic to a minimum.

Allowing the chip to minimize host control, a programmable on-chip DMA controller can be set up by the host to perform unattended burst transfers of any length. A patent-pending scheme provides intelligent arbitration between DMA channels to prevent underflow or overflow, optimizing full-duplex transfers. The controller chip includes the attachment unit interface and a 10Base-T transceiver. The attachment unit can also be bypassed in favor of a custom interface.

Supporting 10Base5, 10Base-T or 10Base2 network connections, the 21040 also handles either "big-" or "little-endian" byte ordering. The 120-lead PQFP-housed chip includes a variety of address filtering modes and permits both external and internal loopback for testing purposes. The chip also has a serial ROM interface for an external Ethernet ID address ROM and support for three LED indicators (network activity, LinkPass, and AUI/10Base-T).

Designed for a 3.3-V supply, the CMOS controller interfaces to 5- or 3.3-V logic and consumes about 1 W at 3.3 V. To simplify in-system chip testing, the controller includes a JTAG test-access port and boundary-scan pins. Software drivers for most popular operating systems are also available. In lots of 5000 units the DECchip 21040 sells for $22.80 each. Samples are available.

Digital Equipment Corp., *77 Reed Road, HL02-2/M09, Hudson, MA 01749; (800) 332-2717 (in U.S.); (508) 568-6868 (outside U.S.)* **CIRCLE 897**

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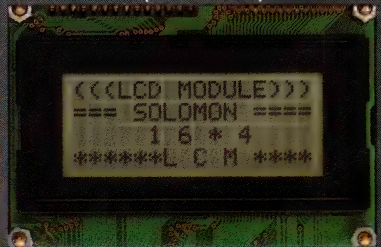

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CIRCLE 156 FOR U.S. RESPONSE
CIRCLE 157 FOR RESPONSE OUTSIDE THE U.S.

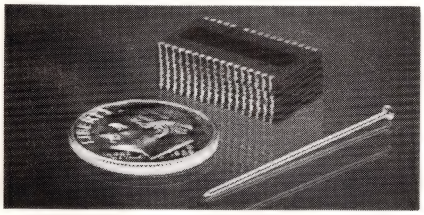
PRINTER/APPLICATOR AUTOMATES PCB IDS

An automated solution for pc-board identification is posed by Brady's thermal-transfer printer/applicator equipment. At the system's core is a Bradyprinter THT Model 203 or 300 thermal-transfer printer. These units produce labels at 203 or 300 dpi, respectively, including high-resolution downloadable fonts or graphics. Designed for flexibility, reliability, and accuracy, complete systems are available for semi-automatic, batch, and in-line board-labeling operations. The systems use BradyLabel Bar Code Plus software or the company's CodeSoft Windows-based software. The applicator portion of the system operates from an on-board programmable-logic controller. Its swing-arm mechanism applies labels at any angle from zero to 360° and maintains a repeatable X/Y label-placement accuracy of ±0.015 in. Call for pricing and delivery information. DM

Brady USA Inc., Industrial Products Div., P.O. Box 2131, Milwaukee, WI 53201; Jim O'Rourke, (800) 537-8791. **CIRCLE 898**

3D MEMORY MODULES TAKE LITTLE PCB SPACE

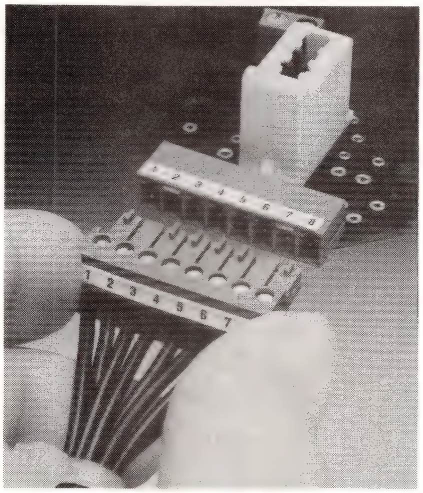
With a footprint of just 0.560 by 0.800 in. and a height of 0.29 in., a 16-Mbyte memory module cuts by 85% the board space consumed by TSOP memories. The DPD16MX8PH4 DRAM-stack module contains eight stackable ceramic carriers, each holding a 4-Mbyte-by-4 DRAM die, and offers 128 Mbits of DRAM in a single 34-pin gull-wing plastic package. The module includes TTL-compatible inputs and outputs and fast access times between 60 and 120 ns, depending on configuration. Call for pricing and delivery information. DM



Dense-Pac Microsystems Inc., 7321 Lincoln Way, Garden Grove, CA 92641-1428; Al Kile, (714) 898-0007. **CIRCLE 930**

SHROUDED HEADERS SAVE PCB SPACE

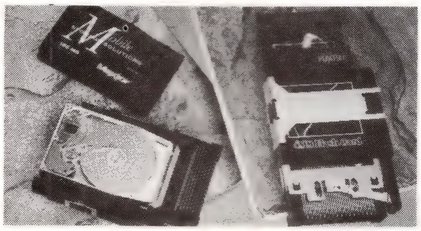
Using the Mini-Combicon 1.5 Series of shrouded headers and plug disconnects gives designers a pc-board-space saving of 25% compared with standard 5- and 5.08-mm products. The units feature centerline spacing of 3.81 mm (0.150 in.) and take advantage of the company's screw-clamp technology to accept stranded or solid wires up to 16 AWG. Available in from two to 16 positions with ratings of 8 A and 300 V, the headers are offered in both horizontal and vertical styles. Call for information regarding pricing and delivery. DM



Phoenix Contact, P.O. Box 4100, Harrisburg, PA 17111; Jeff Holman, (717) 944-1300. **CIRCLE 931**

PCMCIA CONNECTOR TAKES TYPE III CARDS

Valuable pc-board space is saved by the FCN565 PCMCIA-card connectors by virtue of their ability to accept various combinations of Types I, II, and III cards. This eliminates the need to use different connectors for each card type. The connectors consist of two 68-position, right-angle headers that are stacked with no dividing form between them. Each connector accepts two Type I or II cards, one Type I and one Type II card, or one Type III card. To accommodate Type III cards, the header's guide rails are 51 mm apart compared to 49 mm on connectors that accept only Type I and Type II cards. The series include an elevated connector that has a board-mounted height of 14.6 mm. Pricing for the series is $10.56 in lots of 5000. Delivery is in two to four weeks from receipt of order. DM



Fujitsu Microelectronics Inc., Electronic Components Div., 3545 N. First St., San Jose, CA 95134; (800) 642-7616. **CIRCLE 932**

LIGHTWEIGHT INSERT SCREENS OUT EMI

A tiny, featherweight device protects electronic systems from the effects of EMI. The μDISC device is a subminiature circuit board with miniature electrical contacts that places a discrete capacitor between each signal pin and ground in a host connector. The device is quickly and easily installed in less than a minute by fitting it into the small space between any pair of mated cable connectors. The device is available for most commercial and military connectors in a wide range of capacitance values and ratings. It imposes less than 10 mΩ of dc resistance and less than 500 pH of transfer inductance. Call for pricing and delivery information. DM

TRW Inc., Systems Integration Group, One Space Park, Redondo Beach, CA 90278; Al Frascella, (703) 803-5353. **CIRCLE 933**

RANGE OF HEAT SINKS COOLS PENTIUM CPUS

A line of passive and active heat sinks has been developed for cooling Intel's Pentium microprocessor. Active heat sinks are those which include attached fans to force heated air through the fins, while passive heat sinks require no external power. The heat sinks are offered in custom and standard designs and are made from highly conductive extruded aluminum. A large selection of attachment devices is also available. Call for pricing and delivery information. DM

Aavid Engineering Inc., One Kool Path, P.O. Box 400, Laconia, NH 03247-0400; Gary Kuzmin, (603) 528-3400. **CIRCLE 934**

Xicor®

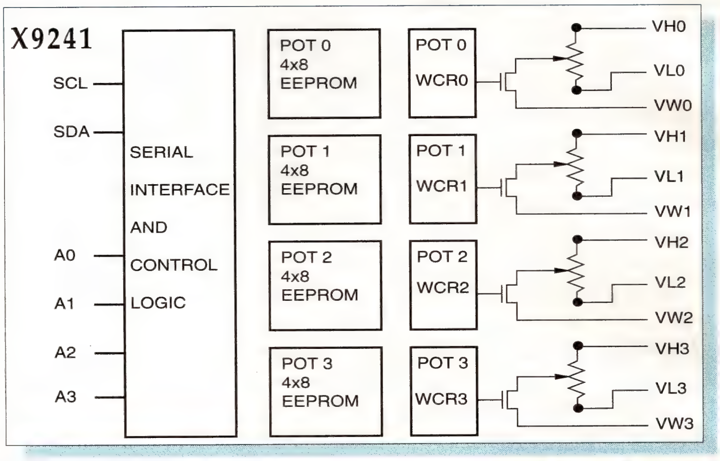
#2
Q4/92

Design Engineers Bulletin

New Product and Applications Information for Design Engineers

Xicor's New X9241 Quad Potentiometer Allows Factory Automation of 64 Potentiometer Adjustments via a Digital Two Wire Serial Bus

For complex systems requiring multiple adjustment capability, Xicor offers the new X9241, Quad E2POT. In addition to retaining wiper positions without power, the X9241 offers a two-wire serial interface for controlling the potentiometers independently or simultaneously using microprocessor control commands. A user programmable address allows up to 16 devices to be software controlled via the common two wire serial bus.



Data Sheet Enclosed

Quad E^2POT Development System

PC based system automates production adjustments of system potentiometers

The XK9241 can be used in a production environment to optimize the settings of the E^2POT.

Faster analog circuit checkout and calibration is made possible by Xicor's new XK9241W Quad E2POT Development System. This system consists of an X9241 evaluation board, interface cables and software which allows a design engineer to control all functions of the Xicor X9241 Quad E2POT from a menu driven system on a IBM PC Compatible computer. The XK9241W Development System allows the design engineer to place the X9241 in a target analog system and perform all adjustments and configuration needed to recognize the features and benefits of the Quad E2POT.

The XK9241 PC based development system can also be used in production environments to automate potentiometer adjustments for initial system calibration.

The XK9241 supports all versions of the X9241 family. It can simultaneously control up to 16 different Quad E2POTs on the same two-wire bus to effectively allow adjustment of 64 individual E2POTs. Orders for the XK9241W can be placed with any authorized Xicor distributor. Suggested resale price is $180.00.

Data Sheet Enclosed

Xicor Inc., 1511 Buckeye Drive, Milpitas, California, 95035 Telephone (408) 432-8888 Fax (408) 432-0640

CIRCLE 234 FOR U.S. RESPONSE CIRCLE 235 FOR RESPONSE OUTSIDE THE U.S.

DC-DC CONVERTERS MEET MILITARY NEEDS

A 16-page catalog describes over 200 dc-dc converters and filter modules from Interpoint Corp., Redmond, Wash. Actual-size part drawings are included for devices designed for military, aerospace, and high-reliability industrial applications. The converters are produced using thick-film hybrid technology for high reliability and small size. Interpoint is fully qualified to create the processes necessary to build converters to MIL-H-38534 and offers models compliant to MIL-STD-883. DM **CIRCLE 900**

SILICON PHOTODIODES FILL THOROUGH GUIDE

A comprehensive guide to silicon photodiodes and related products includes photos, sizes, and specifications for standard and application-specific devices. The 1994 edition of the catalog from Centronic Inc., Newbury Park, Calif., offers full technical details on photodiodes for pulsed operation at near-IR wavelengths; devices for YAG-laser operation; super-UV devices; and many more. Also included are eye-response photodiodes, low-light-level sensors, and general-purpose detectors. A section outlines precautions for handling photodiodes. DM **CIRCLE 901**

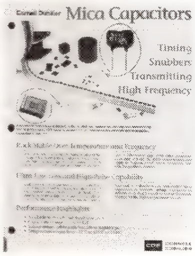
DATA BOOKS DESCRIBE SOLID-STATE CAMERAS

All four of its types of industrial and scientific cameras–line-scan, TDI, high-resolution, and fast-framing–are featured in a 427-page data book from EG&G Reticon, Sunnyvale, Calif. A full 278 pages contain data sheets, while 149 more are filled with application notes and technical papers to assist in the proper use of solid-state cameras. The cameras' CCD and photodiode ICs are detailed, as are the cameras in which they are embedded. Also highlighted are the computer interfaces compatible with each camera and the software for each, as well as a full line of accessories. DM **CIRCLE 902**

SELECTION GUIDE AIDS FREQUENCY CONTROL

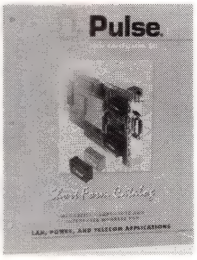
A six-page selection guide for frequency-control products details the full line of crystals and oscillators from SaRonix, Palo Alto, Calif. The guide includes devices for standard and very-high-frequency applications in the computer, network, microwave, data- and tele-communications, and wireless industries. Complete product descriptions with key features, diagrams, and specifications are offered for each product. DM **CIRCLE 903**

MICA CAPACITORS IN LARGE SELECTION



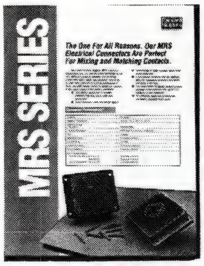
A 44-page catalog from Cornell Dubilier, New Bedford, Mass., presents what is claimed as the world's largest selection of mica capacitors, all characterized for precision control, timing, high-frequency, snubber, and transmitting applications. Mica is rock-stable over temperature and frequency, which makes it a good fit in many applications. The silvered-mica and plate-mica capacitors have typical capacitance change of ±0.5% from –55 to 125°C and less than ±0.1% from zero to full rated voltage. DM **CIRCLE 904**

MAGNETICS CATALOG COVERS PCMCIA ITEMS



An expanding line of ThinSet PCMCIA modules is included in a short-form magnetics catalog from Pulse Engineering Inc., San Diego, Calif. The ThinSet family of fully integrated LAN modules includes low-pass filters, isolation and impedance-matching transformers, common-mode chokes, and resistor networks. The catalog also cross references popular ICs to Pulse's LAN modules. A wide variety of components for the LAN, digital-telecommunication, and data-processing industries are covered. DM **CIRCLE 905**

CONNECTORS DETAILED IN DATA SHEETS



Two data sheets provide full technical information on 16-gauge electrical connectors from Packard-Hughes Interconnect, Irvine, Calif. The MRS connectors offer crimp-removable, solder-tail, shielded, wire-wrap, or fiber-optic contacts. The series accommodates up to 212 contacts in one connector with MIL-C-28748 or equivalent commercial specifications. The C21 Series offers effective sealing with pressure differentials up to 2500 psi in underwater applications. These units meet MIL-C-85028 standards. The data sheets contain complete specifications. DM **CIRCLE 906**

SHORT-FORM CATALOG COVERS COOLING THEORY

A brief tutorial in thermoelectric (Peltier-effect) cooling, as well as technical details on a broad range of standard thermoelectric coolers (TECs), is featured in a short-form catalog from Melcor, Trenton, N.J. The six-page catalog provides a primer on TECs, including theory of operation, applications, and answers to frequently-asked questions about the technology. Selection and performance graphs are presented, as are step-by-step instructions for selecting the optimum cooler for a given application. DM **CIRCLE 907**

BATTERY PRIMER COVERS RECHARGEABLES

A 36-page booklet titled "A To Zinc: Rechargeable Battery Technologies For Portable Computing" serves as a primer on batteries with overviews of current and emerging technologies. The primer, produced by AER Energy Resources Inc., Smyrna, Ga., contains many useful charts and graphs illustrating how batteries work, the battery marketplace, the performance characteristics of various chemistries, and more. An in-depth look at zinc-air technology explains that chemistry's advantages in portable-computing applications. DM **CIRCLE 908**

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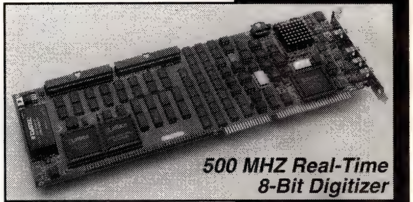

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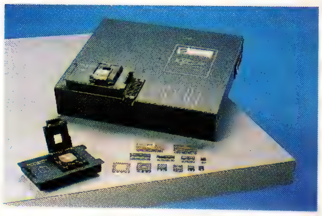

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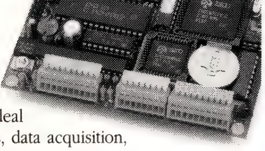

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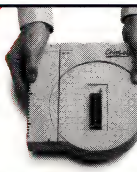

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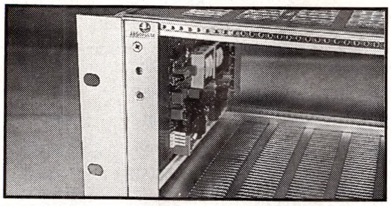

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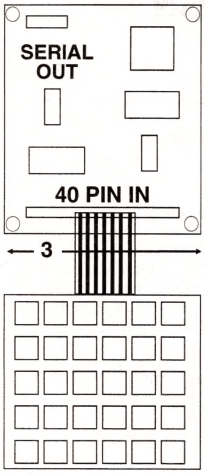

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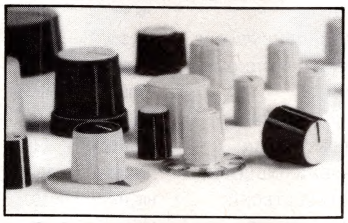

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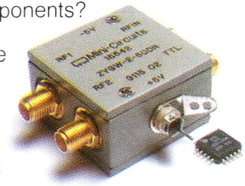

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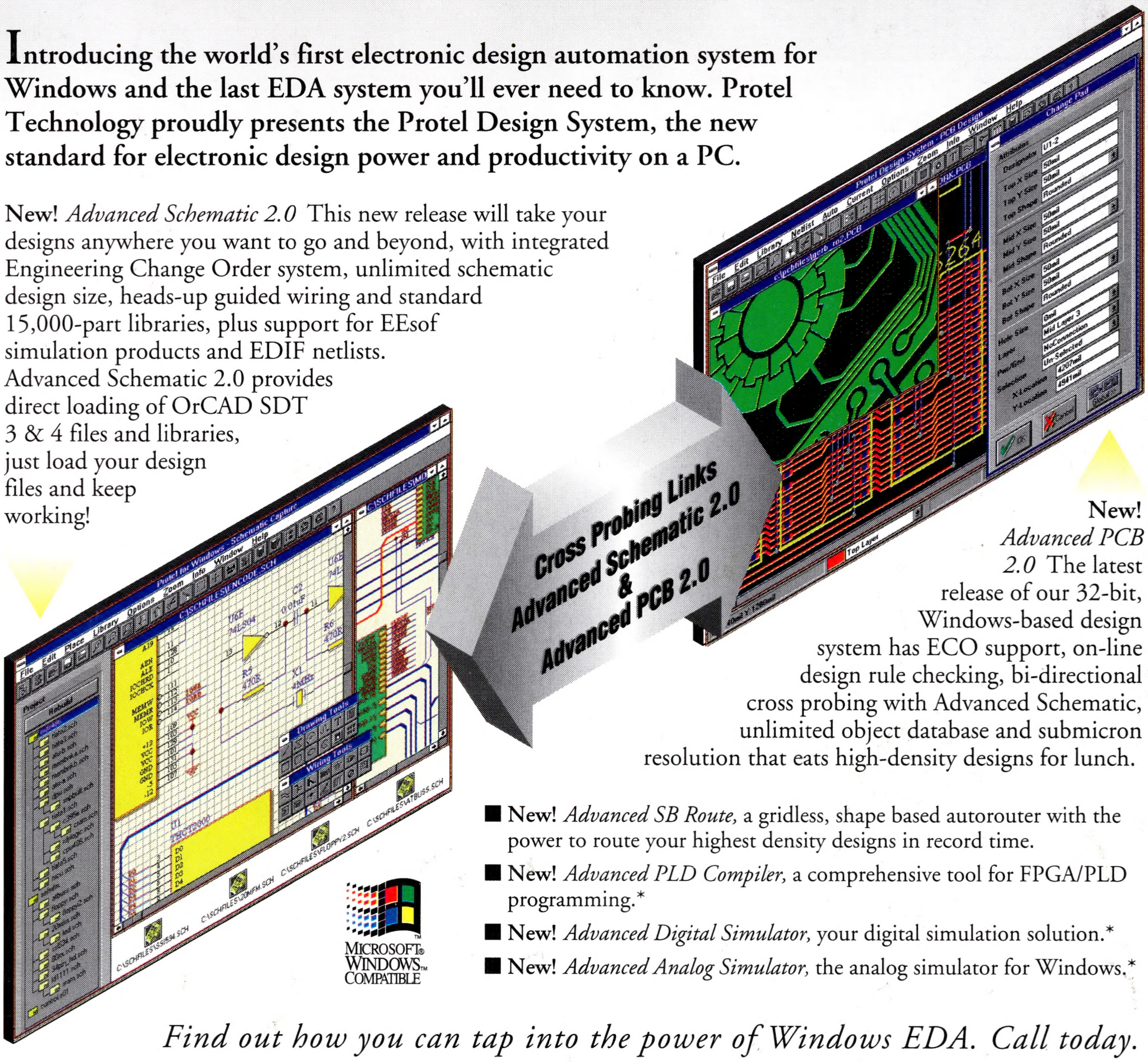

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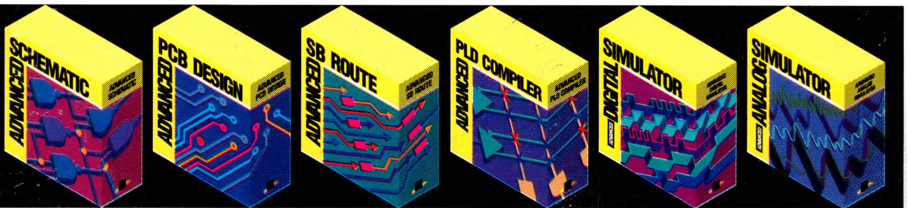

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